SIS A CONVERGE COMPANY

⊓ NetApp

200 Association Drive
Charleston, WV 25311
304 768-1645
304 768-1671 (fax)

May 19, 2020

Ms. Linda B. Harper
Department of Administration
Purchasing Division
2019 Washington Street, East
Charleston, WV 25305

Dear Ms. Harper,

Please find attached the SIS response for CRFQ 0707 LOT20000000009 due May 19, 2020. SIS understands the requirements of the RFQ and is submitting a response offering NetApp HCI and NAS Storage. This response meets or exceeds the mandatory requirements of the RFQ for both the Production and Disaster Recovery sites. The Compute and Storage specifications are exceeded. All Professional Services and Training and Knowledge Transfer as specified in the RFQ are included and all credentials and certifications specified in the RFQ have been met. NetApp HCI provides the West Virginia Lottery with the most advanced Hyper Converged Infrastructure available today. The NAS Storage is ranked Number 1 by Gartner and IDC and is the Number 1 solution for the US Federal Government. The RFQ specifies an "or equal" solution and our response affords the West Virginia Lottery a better than "or equal" solution.

During the last 20 months SIS has implemented Compute and Storage systems for Production and DR for the West Virginia State Treasurer's Office, the West Virginia Department of Education and WV Oasis. Each of these organizations has given SIS permission to use them as a reference. The technologies implemented within these organizations demonstrates our professional capabilities that are being required within the Lottery RFQ. We were low bid on these large complex procurements and we demonstrated our ability to manage large projects on time with customer satisfaction.

In the event that SIS is low bid, we and NetApp would welcome the opportunity to present our capabilities and solution to demonstrate that we meet the West Virginia Lottery RFQ requirements.

Thank you for the opportunity to submit this response and we look forward to further discussions.

Sincerely,

Charles D. Arnett
Senior Client Executive
carnett@thinksis.com

Enclosures

Purchasing Divison
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

State of West Virginia
Request for Quotation
21 — Info Technology

Proc Folder: 698128

Doc Description: Addendum 1 - INFRASTRUCTURE STORAGE SOLUTION AND CONF

Proc Type: Central Master Agreement

Date Issued	Solicitation Closes	Solicitation No		Version
2020-05-13	2020-05-19 13:30:00	CRFQ	0705 LOT2000000009	2

BID RECEIVING LOCATION

BID CLERK
DEPARTMENT OF ADMINISTRATION
PURCHASING DIVISION
2019 WASHINGTON ST E
CHARLESTON WV 25305
US

VENDOR

Vendor Name, Address and Telephone Number:

Software Information Systems (SIS)
165 Barr Street
Lexington, KY 40507
859.977.4796

FOR INFORMATION CONTACT THE BUYER
Linda B Harper
(304) 558-0468
linda.b.harper@wv.gov

Signature X _(signed)_   FEIN # 61-1371685   DATE 5-15-2020

All offers subject to all terms and conditions contained in this solicitation

Addendum 1 issued for the following reasons:

1. To publish a copy of vendor questions and responses.

2. To modify the pricing page, see attached Exhibit A Pricing Page - Revised for Addendum 1.

No other changes

INVOICE TO		SHIP TO	
ACCOUNTS PAYABLE		PURCHASING	
LOTTERY		LOTTERY	
PO BOX 2067		900 PENNSYLVANIA AVE	
CHARLESTON	WV 25327-2067	CHARLESTON	WV 25302
US		US	

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
1	Computer servers - ENTER TOTAL BID AMOUNT FROM EXHIBIT A				$1,350,000.00

Comm Code	Manufacturer	Specification	Model #
43211501			

Extended Description :
VENDORS SUBMITTING BIDS ONLINE SHOULD ENTER THE TOTAL BID AMOUNT FROM THE EXHIBIT A PRICING PAGE (CONTRACT AMOUNT) AND ATTACH A COPY WITH THEIR BID SUBMISSION

Line	Event	Event Date
1	Question Deadline 2:00 pm	2020-05-11

STATE OF WEST VIRGINIA
Purchasing Division

PURCHASING AFFIDAVIT

CONSTRUCTION CONTRACTS: Under W. Va. Code § 5-22-1(i), the contracting public entity shall not award a construction contract to any bidder that is known to be in default on any monetary obligation owed to the state or a political subdivision of the state, including, but not limited to, obligations related to payroll taxes, property taxes, sales and use taxes, fire service fees, or other fines or fees.

ALL CONTRACTS: Under W. Va. Code §5A-3-10a, no contract or renewal of any contract may be awarded by the state or any of its political subdivisions to any vendor or prospective vendor when the vendor or prospective vendor or a related party to the vendor or prospective vendor is a debtor and: (1) the debt owed is an amount greater than one thousand dollars in the aggregate; or (2) the debtor is in employer default.

EXCEPTION: The prohibition listed above does not apply where a vendor has contested any tax administered pursuant to chapter eleven of the W. Va. Code, workers' compensation premium, permit fee or environmental fee or assessment and the matter has not become final or where the vendor has entered into a payment plan or agreement and the vendor is not in default of any of the provisions of such plan or agreement.

DEFINITIONS:

"Debt" means any assessment, premium, penalty, fine, tax or other amount of money owed to the state or any of its political subdivisions because of a judgment, fine, permit violation, license assessment, defaulted workers' compensation premium, penalty or other assessment presently delinquent or due and required to be paid to the state or any of its political subdivisions, including any interest or additional penalties accrued thereon.

"Employer default" means having an outstanding balance or liability to the old fund or to the uninsured employers' fund or being in policy default, as defined in W. Va. Code § 23-2c-2, failure to maintain mandatory workers' compensation coverage, or failure to fully meet its obligations as a workers' compensation self-insured employer. An employer is not in employer default if it has entered into a repayment agreement with the Insurance Commissioner and remains in compliance with the obligations under the repayment agreement.

"Related party" means a party, whether an individual, corporation, partnership, association, limited liability company or any other form or business association or other entity whatsoever, related to any vendor by blood, marriage, ownership or contract through which the party has a relationship of ownership or other interest with the vendor so that the party will actually or by effect receive or control a portion of the benefit, profit or other consideration from performance of a vendor contract with the party receiving an amount that meets or exceed five percent of the total contract amount.

AFFIRMATION: By signing this form, the vendor's authorized signer affirms and acknowledges under penalty of law for false swearing (*W. Va. Code* §61-5-3) that: (1) for construction contracts, the vendor is not in default on any monetary obligation owed to the state or a political subdivision of the state, and (2) for all other contracts, that neither vendor nor any related party owe a debt as defined above and that neither vendor nor any related party are in employer default as defined above, unless the debt or employer default is permitted under the exception above.

WITNESS THE FOLLOWING SIGNATURE:

Vendor's Name: Software Information Systems, LLC

Authorized Signature: _(signature)_   Date: 5-17-2020

State of Kentucky

County of Fayette   , to-wit:

Taken, subscribed, and sworn to before me this 17 day of ___May___, 2020.

My Commission expires March 27   , 2020.

(notary seal: KAREN A. SMALLWOOD, NOTARY PUBLIC, ID NO. 574503, MY COMMISSION EXPIRES 3/27/2021, STATE AT LARGE, KY)

NOTARY PUBLIC _(signature)_

Purchasing Affidavit (Revised 01/19/2018)

ADDENDUM ACKNOWLEDGEMENT FORM
SOLICITATION NO.: LOT2000000009

Instructions: Please acknowledge receipt of all addenda issued with this solicitation by completing this addendum acknowledgment form. Check the box next to each addendum received and sign below. Failure to acknowledge addenda may result in bid disqualification.

Acknowledgment: I hereby acknowledge receipt of the following addenda and have made the necessary revisions to my proposal, plans and/or specification, etc.

Addendum Numbers Received:
(Check the box next to each addendum received)

[✓] Addendum No. 1   [ ] Addendum No. 6

[ ] Addendum No. 2   [ ] Addendum No. 7

[ ] Addendum No. 3   [ ] Addendum No. 8

[ ] Addendum No. 4   [ ] Addendum No. 9

[ ] Addendum No. 5   [ ] Addendum No. 10

I understand that failure to confirm the receipt of addenda may be cause for rejection of this bid. I further understand that any verbal representation made or assumed to be made during any oral discussion held between Vendor's representatives and any state personnel is not binding. Only the information issued in writing and added to the specifications by an official addendum is binding.

Software Infrastructure System, LLC
Company

[signature]
Authorized Signature

_5-17-2015_
Date

NOTE: This addendum acknowledgement should be submitted with the bid to expedite document processing.
Revised 6/8/2012

CRFQ 0705 LOT2000000009

Pricing Exhibit A

Item	Qty	Part Number	Description
			NetApp HCI replaces VxRail
1	1	Part Number	
2	1	H-SERIES-MODEL	H-Series,SSA
3	1	H-SERIES-SSA	H-Series Chassis,2x4,-C
4	3	H410E-00001-C	H410C-14020,Compute Node
5	3	H410C-14020-COMP-NODE	CompNode,2xSKL4110,16Core,384G,2x4,-C
6	1	H410C-14020-C	4hr Parts Replacement
7	1	CS-4HR-REPLACEMENT	SupportEdge Advisor
8	5	CS-G1-SE-ADVISOR	
9	5	H610S-1-MODEL-P	SOLIDFIRE,960GB,12 DRIVES,NODE,-P
10	5	H610S-1-P	4hr Parts Replacement
11	5	CS-4HR-REPLACEMENT	SupportEdge Advisor
12	2	CS-G1-SE-ADVISOR	
13	800	SW-CLOUDVOL-M300-PREM	SW,CloudVolumes,Backend,OTS,Premium
14	800	SW-CLOUDVOL-M300-PREMIUM	SW Support,Cloud Volumes,OTS,Premium
15	1	SW-SSP-CLOUDVOL-M300-PREM	
16	58	SW-H-SERIES-CAP-TERM	SW,H-Series,Capacity,5YR,1TB
17	1	SW-H-SERIES-5Y-1T	4hr Parts Replacement
18	1	CS-4HR-REPLACEMENT	SupportEdge Advisor
19	8	CS-G1-SE-ADVISOR	PS Deployment,HCI
Item	**Qty**	**Part Number**	**Description**
			FAS8200 Replaces Isilon
20	1	SW-2-CL-BASE	SW-2,Base,CL,Node
21	1	FAS8200	
22	2	FAS8200A-002	FAS8200 HA System,Premium Bundle
23	2	SW-2-8200A-NVE-C	SW,Data at Rest Encryption Enabled,8200A,-C
24	2	SW-2-8200A-TPM-C	SW,Trusted Platform Module Enabled,8200A,-C
25	2	X6566B-05-R6-C	Cable,Direct Attach CU SFP+ 10G,0.5M,-C
26	8	X66250-5-C	Cable,LC-LC,OM4,5m,-C
27	4	X66032A-C	Cable,12Gb,Mini SAS HD,2m,-C
28	1	X6235-C	Chassis,FAS8200,AFF-A300,AC PS,-C
29	1	DS460C-07-4.0-30B-2P-C	Disk Shelf,12G,30x4TB,7.2K,2P,-C
30	1	DOC-8200-C	Documents,8200,-C
31	2	X3313A-C	FlashCache Upgrade,2TB,-C
32	2	DATA-AT-REST-ENCRYPTION	Data at Rest Encryption Capable Operating Sys
33	2	X800-42U-R6-C	Power Cable,In-Cabinet,C13-C14,-C

34	2	X-02659-00-C	Rail Kit,4-Post,Rnd/Sq-Hole,Adj,24-32,-C
35	1200	OS-ONTAP1-CAP1-PREM-2P-C	ONTAP,Per-0.1TB,PREMBNDL,Capacity,2P,-C
36	8	X6599A-R6-C	SFP+ Optical 10Gb Shortwave,-C
37	1	PS-DEPLOY-STAND-FAS-L	PS Deployment,Standard,FAS,Low
38	1	CS-SUPPORT-MANAGEMENT	Supplemental Support Management
39	1	CS-WARRANTY-EXTENSION	Warranty Extension
40	1	CS-O2-4HR	SupportEdge Premium 4hr Onsite

	Qty	Part Number	Description
			FAS8200 Replace IDPA
41	1	SW-2-CL-BASE	SW-2,Base,CL,Node
42	1	FAS8200	
43	2	FAS8200A-002	FAS8200 HA System,Premium Bundle
44	2	SW-2-8200A-NVE-C	SW,Data at Rest Encryption Enabled,8200A,-C
45	2	SW-2-8200A-TPM-C	SW,Trusted Platform Module Enabled,8200A,-C
46	2	X6566B-05-R6-C	Cable,Direct Attach CU SFP+ 10G,0.5M,-C
47	8	X66250-5-C	Cable,LC-LC,OM4,5m,-C
48	4	X66032A-C	Cable,12Gb,Mini SAS HD,2m,-C
49	1	X6235-C	Chassis,FAS8200,AFF-A300,AC PS,-C
50	1	DS460C-07-4.0-30B-2P-C	Disk Shelf,12G,30x4TB,7.2K,2P,-C
51	1	DOC-8200-C	Documents,8200,-C
52	2	X3313A-C	FlashCache Upgrade,2TB,-C
53	2	DATA-AT-REST-ENCRYPTION	Data at Rest Encryption Capable Operating Sys
54	2	X800-42U-R6-C	Power Cable,In-Cabinet,C13-C14,-C
55	2	X-02659-00-C	Rail Kit,4-Post,Rnd/Sq-Hole,Adj,24-32,-C
56	1200	OS-ONTAP1-CAP1-PREM-2P-C	ONTAP,Per-0.1TB,PREMBNDL,Capacity,2P,-C
57	8	X6599A-R6-C	SFP+ Optical 10Gb Shortwave,-C
58	1	PS-DEPLOY-STAND-FAS-L	PS Deployment,Standard,FAS,Low
59	1	CS-SUPPORT-MANAGEMENT	Supplemental Support Management
60	1	CS-WARRANTY-EXTENSION	Warranty Extension
61	1	CS-O2-4HR	SupportEdge Premium 4hr Onsite

	Qty	Part Number	Description
			Compute Replaces PowerEdge Servers
62	1	H-SERIES-MODEL	
63	1	H-SERIES-SSA	H-Series,SSA
64	1	H410E-00001-C	H-Series Chassis,2x4,-C
65	3	H410C-14020-COMP-NODE	H410C-14020,Compute Node
66	3	H410C-14020-C	CompNode,2xSKL4110,16Core,384G,2x4,-C
67	1	CS-4HR-REPLACEMENT	4hr Parts Replacement
68	1	CS-G1-SE-ADVISOR	SupportEdge Advisor
69	3	PS-DEPLOY-HCI	PS Deployment,HCI

	Qty	Part Number	Description
			NetApp HCI replaces VxRail
70	1	Part Number	
71	1	H-SERIES-MODEL	H-Series,SSA
72	1	H-SERIES-SSA	H-Series Chassis,2x4,-C
73	3	H410E-00001-C	H410C-14020,Compute Node
74	3	H410C-14020-COMP-NODE	CompNode,2xSKL4110,16Core,384G,2x4,-C
75	1	H410C-14020-C	4hr Parts Replacement
76	1	CS-4HR-REPLACEMENT	SupportEdge Advisor
77	5	CS-G1-SE-ADVISOR	
78	5	H610S-1-MODEL-P	SOLIDFIRE,960GB,12 DRIVES,NODE,-P
79	5	H610S-1-P	4hr Parts Replacement

Item	Qty	Part Number	Description
80	5	CS-4HR-REPLACEMENT	SupportEdge Advisor
81	2	CS-G1-SE-ADVISOR	
82	800	SW-CLOUDVOL-M300-PREM	SW,CloudVolumes,Backend,OTS,Premium
83	800	SW-CLOUDVOL-M300-PREMIUM	SW Support,Cloud Volumes,OTS,Premium
84	1	SW-SSP-CLOUDVOL-M300-PREM	
85	58	SW-H-SERIES-CAP-TERM	SW,H-Series,Capacity,5YR,1TB
86	1	SW-H-SERIES-5Y-1T	4hr Parts Replacement
87	1	CS-4HR-REPLACEMENT	SupportEdge Advisor
88	8	CS-G1-SE-ADVISOR	PS Deployment,HCI

Item	Qty	Part Number	Description
			FAS8200 Replace Isilon
89	1	SW-2-CL-BASE	SW-2,Base,CL,Node
90	1	FAS8200	
91	2	FAS8200A-002	FAS8200 HA System,Premium Bundle
92	2	SW-2-8200A-NVE-C	SW,Data at Rest Encryption Enabled,8200A,-C
93	2	SW-2-8200A-TPM-C	SW,Trusted Platform Module Enabled,8200A,-C
94	2	X6566B-05-R6-C	Cable,Direct Attach CU SFP+ 10G,0.5M,-C
95	8	X66250-5-C	Cable,LC-LC,OM4,5m,-C
96	4	X66032A-C	Cable,12Gb,Mini SAS HD,2m,-C
97	1	X6235-C	Chassis,FAS8200,AFF-A300,AC PS,-C
98	1	DS460C-07-4.0-30B-2P-C	Disk Shelf,12G,30x4TB,7.2K,2P,-C
99	1	DOC-8200-C	Documents,8200,-C
100	2	X3313A-C	FlashCache Upgrade,2TB,-C
101	2	DATA-AT-REST-ENCRYPTION	Data at Rest Encryption Capable Operating Sys
102	2	X800-42U-R6-C	Power Cable,In-Cabinet,C13-C14,-C
103	2	X-02659-00-C	Rail Kit,4-Post,Rnd/Sq-Hole,Adj,24-32,-C
104	1200	OS-ONTAP1-CAP1-PREM-2P-C	ONTAP,Per-0.1TB,PREMBNDL,Capacity,2P,-C
105	8	X6599A-R6-C	SFP+ Optical 10Gb Shortwave,-C
106	1	PS-DEPLOY-STAND-FAS-L	PS Deployment,Standard,FAS,Low
107	1	CS-SUPPORT-MANAGEMENT	Supplemental Support Management
108	1	CS-WARRANTY-EXTENSION	Warranty Extension
109	1	CS-O2-4HR	SupportEdge Premium 4hr Onsite

Item	Qty	Part Number	Description
			FAS8200 Replace IDPA
110	1	SW-2-CL-BASE	SW-2,Base,CL,Node
111	1	FAS8200	
112	2	FAS8200A-002	FAS8200 HA System,Premium Bundle
113	2	SW-2-8200A-NVE-C	SW,Data at Rest Encryption Enabled,8200A,-C
114	2	SW-2-8200A-TPM-C	SW,Trusted Platform Module Enabled,8200A,-C
115	2	X6566B-05-R6-C	Cable,Direct Attach CU SFP+ 10G,0.5M,-C
116	8	X66250-5-C	Cable,LC-LC,OM4,5m,-C
117	4	X66032A-C	Cable,12Gb,Mini SAS HD,2m,-C
118	1	X6235-C	Chassis,FAS8200,AFF-A300,AC PS,-C
119	1	DS460C-07-4.0-30B-2P-C	Disk Shelf,12G,30x4TB,7.2K,2P,-C
120	1	DOC-8200-C	Documents,8200,-C
121	2	X3313A-C	FlashCache Upgrade,2TB,-C
122	2	DATA-AT-REST-ENCRYPTION	Data at Rest Encryption Capable Operating Sys
123	2	X800-42U-R6-C	Power Cable,In-Cabinet,C13-C14,-C
124	2	X-02659-00-C	Rail Kit,4-Post,Rnd/Sq-Hole,Adj,24-32,-C
125	1200	OS-ONTAP1-CAP1-PREM-2P-C	ONTAP,Per-0.1TB,PREMBNDL,Capacity,2P,-C
126	8	X6599A-R6-C	SFP+ Optical 10Gb Shortwave,-C

Item	Qty	Part Number	Description
127	1	PS-DEPLOY-STAND-FAS-L	PS Deployment,Standard,FAS,Low
128	1	CS-SUPPORT-MANAGEMENT	Supplemental Support Management
129	1	CS-WARRANTY-EXTENSION	Warranty Extension
130	1	CS-O2-4HR	SupportEdge Premium 4hr Onsite

Item	Qty	Part Number	Description
131	600	NetApp Training Credits	Equals 45000 Dell training credits (42,300 requested)
132	975	VMware Service Credits SVC-CR-20	975 for CONSULTING & TRAINING CREDITS RFQ 4.37.6
133	260	VMware Service Credits SVC-CR-20	260 creditsLiveOnlineTraining VSphere FastTrack V6.7 5 Days 4 perso
134	104	VMware Service Credits SVC-CR-20	104 Credits for Online Training for vSAN: Deploy & Manage V6.7
135	68	VMware Service Credits SVC-CR-20	68 Credits for Onlne Training for SRM: Install, Configure Manage V6.1

Item	Qty	Part Number	Description

All Services are included per Project Scope
Training is included per Requirements
Total Bid: $1,350,0000

Custom Work Pricing

Clustered SQL Server Replatform	Vendor Support*	100/$225
Domain Controller and Active Directory Migration	Active Directory Vendor Support migration*	100/$225
Clustered Microsoft Exchange Server Migration	Exchange Webmail and Presence Support*	100/$225
Radius and Printer Server Migration	Vendor Support Authenctication and Printing*	100/$225

All Components are included

SIS Credentials

Visual Studio 2010 Team Foundation Server, Administration	1	Lexington, KY
• MCSA -- Microsoft Certified Systems Administrator		
Microsoft Certified Systems Administrator	4	Nicholasville, KY Indianapolis, IN, Cincinnati, OH Los Angeles
• MCSE - Microsoft Systems Certified Engineer		
Microsoft Certified System Engineer	4	Nicholasville, KY Indianapolis, IN Cincinnati, OH Los Angeles, CA
• MCSD - Microsoft Certified Solution Developer		
Microsoft Certified Solution Developer (VB 6)	1	New Hampshire
Microsoft Certified Solution Developer (.NET)	1	New Hampshire
• MCPD - Microsoft Certified Professional Developer		
MCPD Web Developer	1	Lexington, KY
MCPD Enterprise Application Developer 3.5	1	Lexington, KY
MCPD SharePoint 2010	1	Lexington, KY
• MCITP Microsoft Certified IT Professional		
MCITP Database Administrator 2008	2	Lexington, KY and New Hampshire
MCITP Enterprise Administrator 2008	1	Cincinnati, OH
MCITP SharePoint Administrator 2010	1	Lexington
MCITP Database Developer 2008	2	Lexington, KY and New Hampshire
MCITP Database Administrator 2005	1	Lexington, KY
Non-Certified MS Technicians and Geographical break down		
MS Consulting	3 Non-certified Technicians	Total of 15 MS Consultants (12 Certified and 3 non-certified technicians)
	5	Lexington, KY
	5	Louisville, KY
	1	Indianapolis, IN
	1	Cincinnati, OH
	1	Columbus, OH
	1	New Hampshire
	1	Los Angeles, CA

Strategy | Technology | Results

David Griffin

David Griffin is a Senior Solutions Engineer at SIS specializing in Infrastructure and Virtualization technology projects.

Certifications and Related Skills

- Server Virtualization – VMware Certified Professional 6 – Data Center Virtualization, VMware Technical Sales Professional 2016, VMware Technical Sales Professional – Software-Defined Storage 2016, VMware Technical Sales Professional – Management Operations and VMware Technical Sales Professional – Business Continuity
- Backup Application – Veeam Technical Sales Professional 9, Veeam Certified Engineer 9 and Symantec Backup Exec Sales Expert Plus
- Desktop and Application Virtualization – VMware Technical Sales Professional – Desktop Virtualization 2015 and VMware Technical Sales Professional Mobility
- Networking – Cisco Certified Network Associate Routing and Switching
- Operating System – Microsoft Certified Systems Engineer Windows 2003
- Technical Engineering
- Technical Project Management
- Technical Documentation

Industry: Healthcare
Project: VMware vSphere Upgrade

Project technical lead for a healthcare client to upgrade VMware vSphere 5.1 to 6.0 with 155 hosts and 2200 virtual machines with zero downtime
- Oversaw the project from a technical point of view
- Documented upgrade process for IT committee change control approval
- Worked closely with onsite client project managers for business unit communications
- Performed VMware vCenter and ESXi upgrades during normal business hours with no performance impact
- Documented environment for published policy and ISO 9001 requirements

Industry: Manufacturing
Project: VMware vSphere Upgrade and hardware replacement

Project technical lead for a 24/7 manufacturing client to upgrade VMware vSphere 5.1 to 5.5 with 4 hosts and 70 virtual machines with zero downtime
- Oversaw the project from a technical point of view
- Replaced legacy server and SAN hardware with Cisco UCS and IBM Storwize v7000
- Deployed vSphere 5.5 in new environment per business requirements
- Migrated VMware vSphere environment from legacy to new hardware during normal business hours with no performance impact
- Documented environment

Industry: Healthcare
Project: Operating system and application upgrade

Virtualization technical lead for a healthcare client yearlong project to upgrade Windows servers and migrate data
- Within two replicated datacenters, deployed 72 Windows 2008 R2 Server virtual machines to satisfy 8 business units
- Managed low storage resources and migration during upgrade
- Worked with application vendors for application upgrade and Windows 2012 R2 limitation discovery
- Oversaw all virtualization activities during scheduled outage production migration
- Documented environment and all change control requirements

Industry: Education
Project: VMware host and storage integration

Project technical lead to integrate new VMware ESXi hosts and storage into existing postsecondary education environment

- Installed/Configured 3 Lenovo System x3650 M4 servers and an IBM Storwize v3700 SAN into a vSphere 5.5 environment
- Updated vCenter 5.5 to current patch level
- Performed a group knowledge transfer/jumpstart on usage/management of the IBM Storwize v3700 SAN
- Documented environment

Jeff Downs

Jeff Downs is a Senior Solutions Engineer at SIS specializing in Infrastructure and Virtualization technology projects.

Certifications and Related Skills

- Server Virtualization
- Desktop and Application Virtualization
    - VMware Technical Sales Professional
    - VMware Technical Sales Professional Mobility
- Microsoft
    - SCCM
    - Active Directory
    - Group Policies
    - Golden Image Creation
    - Migration\Upgrades
- Technical Engineering
- Technical Project Management
- Technical Documentation

Project and Work History

Industry: Manufacturing
Project: VMware Install and Migration

Technical lead for a manufacturing client to upgrade install and configure new Vsphere 6.5 cluster and migrate from existing vSphere 5.5 with 2 hosts and 30 virtual machines with zero downtime
- Oversaw the project from a technical point of view
- Performed VMware vCenter and ESXi install and migration during normal business hours with no performance impact
- Creation of as-built projection documentation to be given to the customer

Industry: Healthcare
Project: Operating system and Filesever upgrade

Technical lead for a healthcare client to upgrade Windows fileserver with redirected folders and migrate data
- Creation of new filesever
- Created process to copy over files and cut over server
- Cut over client off hours without any issues

Industry: Education
Project: VMware host and storage integration

Technical lead to integrate new VMware ESXi hosts and storage into existing education environment
- Install and configure of new Dell storage and servers
- Creation and configuration of new VMs
- Migration of existing VMs into new environment

BJ Schwein

BJ Schwein is a Converged Solutions Architect at SIS specializing in Compute, HCI, VMware & BCDR projects.

Certifications and Related Skills

- VMware Certified Professional 6 – Data Center Virtualization
- BCDR – Zerto Certified Professional Enterprise Engineer
- HCI – VMware Technical Sales Professional – Hyper-Converged Infrastructure
- Technical Engineering
- Technical Project Management
- Technical Documentation

Project and Work History

Industry: Healthcare
Project: VMware vSphere & Horizon Upgrade

1

Lead engineer for a healthcare client for a VMware vSphere 5.5 to 6.7 upgrade and Horizon upgrade

- Worked with Sr Admin client to review and plan the upgrades
- Replaced rack mount x86 servers with Cisco UCS blades
- Deployed new VMware vCenter servers and ESXi Hosts
- Deployed new Horizon 7 components
- Migrated virtual machines from old environment to new environment
- Provided technical Documentation

Industry: State Government
Project: VMware vSphere & Site Recovery Manager Upgrade

Lead engineer for a State Government agency to replace a VMware vSphere 6.5 environment with new hardware and vSphere 6.7 for Production and DR

- Installed new Cisco UCS HW for Prod and DR
- Deployed new VMware vCenter servers and ESXi Hosts for Prod and DR
- Deployed new SRM Servers for Prod and DR
- Provided technical Documentation

Industry: Food
Project: HW Upgrade

Lead engineer for a client to replace aging UCS blades with current generation of UCS blades

- Upgraded UCS Manager firmware
- Performed rolling replacement of UCS blades running a production VMware environment with zero downtime
- Upgraded UCS Blade firmware
- Provided UCS health check post upgrade

Industry: Manufacturing
Project: VMware upgrade & HW replacement

Lead engineer working with client to replace aging x86 servers and upgrade VMware vSphere from 5.5 to 6.7

- Installed new x86 servers and integrated into existing storage
- Deployed new vCenter 6.7 server
- Performed rolling replacement of production VMware Hosts
- Installed and configured ESXi on new servers
- Provided technical Documentation

Nicholas Loghides

Nicholas Loghides is a Senior Consultant and the Microsoft Data Platform Lead at SIS specializing in SQL Server related services, implementations, architecture, managed services and performance tuning. He is formerly a .NET developer with application design and code experience mainly in C# and VB.net.

Certifications and Related Skills

- Microsoft Certified Solutions Expert - Data Platform
- Microsoft Certified Solutions Associate - SQL Server 2012
- MCITP Database Administrator 2008
- MCP Certified Professional
- Microsoft Certified Solution Developer (Visual Studio 6)
- Microsoft Certified Solution Developer (.NET)
- Microsoft Certified Application Developer (.NET)
- MCTS .NET Framework 4 Web
- MCTS SQL Server 2008 Implementation and Maintenance
- MCTS SQL Server 2008 Database Development
- MCITP Database Developer 2008
- Idera Professional Services Partner
- Microsoft SQL Server 2000, 2005, 2008, 2008 R2, 2012, 2014, 2016, 2017, 2019
- SQL Server High Availability (Log Shipping, AlwaysOn, Failover Clustering, Mirroring)
- SQL Server Performance Tuning
- SQL Server DBA Managed Services
- TSQL
- .NET 2-4.5
- Visual C#, VB.NET

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- SSRS, SSIS
- Windows Servers, AD, System Administration
- Virtualization Hyper-V, VM Ware
- Cloud Computing
- Azure, Azure Database
- Database Design
- Idera Implementation
- FusionIO/SanDisk Implementation
- Basic Linux Familiarity
- Airline Transport Pilot Certificate - US Federal Aviation Administration (FAA)
- Certified US Naval Tactical Jet Flight Instructor

Historical and Ongoing Activities

Industry: Healthcare, Finance, Production, Manufacturing, Retail, Vehicle Tracking, Government, and others
SIS Offering: Microsoft SQL Server Database Administrator (DBA) Managed Services

Senior Database Administrator (DBA) providing monitoring, proactive and reactive activities/remediation around critical data-centric environments. Deliverables include but are not limited to:
- Risk mitigation/elimination
- Senior DBA expertise as part of a team or where none or minimal exist
- World class monitoring software
- 24/7 monitoring and alerting
- Alert response and review
- Immediate/near-immediate/high priority response and assistance
- Dedicated monitoring/review each month and dedicated DBA activities each month – two engagements under one name
- Perpetual SQL Server diagnostics with a goal of iteratively and continually perfecting SQL Server environments
- SQL Server strategy, planning and architecture
- SQL Server performance tuning

Industry: Healthcare, Finance, Production, Retail, Vehicle Tracking, Government, and others
SIS Offering: DBA Services (Project based or ad hoc)

This senior SQL Server DBA work spans many activities that include but are not limited to:

- Consolidations
- Migrations
- Upgrades
- Specialized SQL Server feature implementation
- High Availability – Log Shipping, AlwaysOn Availability, SQL Server Failover Clustering
- Architecture and Design
- SQL Server diagnostics and performance tuning
- Break fix support
- Dedicated multi-day SQL Server Diagnostic Check
- Miscellaneous DBA tasks

Eric Schroeder ███████████

Accomplished hands on IT Manager and Solutions Architect with a proven ability to develop and implement software that supports organization effectiveness, business objectives and Enterprise IT functionality. I think in diverging directions to involve a variety of aspects which sometimes leads to novel ideas and solutions.

Areas of Expertise
- Team leadership and quality management
- Enhancing availability by developing cloud solutions
- Enhancing product and software applications
- Developing user training and solutions
- Building collaborative vendor partnerships

Professional Attributes
- Broad knowledge and understanding in designing client networks to fulfill demands
- Office 365, Azure/AWS/GCP Cloud and ERP technologies; implementation & design
- Competent in managing full enterprise networks in 24x7 environments
- IT project management of new domain construction
- Recognized for ability to handle multiple projects efficiently and meet them to completion
- Recognized for creating innovative thinking within groups and projects
- Acknowledged for communicating complex issues into user-friendly terms
- Responsible for training 36 new employees, resulting in nearly 100% retention
- Received six bi-annual reviews indicating "excellent communication skills" ratings
- Successfully reduced annual expense costs per year by $425,000

Support, design, configuration, implementation, and administration in the following areas:
- Azure/G Suite/AWS Architecture
- Automation Technologies (Docker, Puppet, Packer)
- Cisco UCS, Nutanix and Datrium HCI
- VMware vCenter, vRops, VUM
- SAP/ERP Management
- Connect Wise Manage
- Wordpress Design/Management
- Enterprise Antivirus Management and remediation
- Office 365, Sharepoint Online, Azure, O365
- Oracle JDE E1 Administration
- ManageEngine Tools/AD Manager/ServiceDesk/ADAudit Plus
- SQL Server 2008/2012/2016
- Load balancing technologies/management (BigIP/F5)
- System Center Configuration Manager SCCM 2012
- SAN Architect and design
- Microsoft Server 2003-2016
- Symantec Endpoint/Backup Exec
- SharePoint Development 2007/2012

- GPO/DFS/Active Directory and DNS management
- MS Exchange Server 2007/2010
- Linux Administration/Ubuntu/RHEL
- Veeam Enterprise Backup and Disaster Recovery

Network Experience
- Cisco routers/Security appliances', VPN
- Cisco/Fortinet/Watchguard/Sonicwall Firewall configuration and management
- HP Virtual Connect Fiber Manager
- HP Storage Array Cluster Management

Work History

Nordisk Systems - Solutions Architect/Senior Systems Engineer (07/2019 - Current)
- Architect Customer systems around specification requirements
- Azure/AWS/GCP Team for deployments and migrations
- Cloud Design and build outs
- UCS Config and Build outs
- SOW customer support
- Automation technologies to assist Enterprise businesses (Docker, Puppet)
- Work alongside Sales team to architect systems according to customer needs
- Connect Wise design and administration

Hillsboro School District - Senior Systems Administrator/Solutions Architect (03/2018 - 07/2019)
- Worked on projects to move VMware VDI and other solutions to AWS cloud environment
- Redesign Authentication Architecture with Azure AD, G Suite and AWS
- VMware Infrastructure management and redesign
- Update older Cisco UCS environment to new solution (AWS based)
- Architect AWS Cloud solution options for all aspects of infrastructure
- Orion NPM/SAM and SIEM Management
- Change Control Management
- IT Budget Planning for AWS Cloud design
- Manage and monitor VMware infrastructure
- Monitor entire infrastructure across 46 building with over 30,000 users

IT Manager/Infrastructure Architect – ICTSI Oregon North America   (08/01/2015-03/2018)
- Hands on management for maintenance/troubleshooting for the infrastructure, network, telecommunications and portals; ensuring security, virus protection, sensitive data and stability are maintained in a 24x7 working environment
- SharePoint Online Integration into Production business practices via document warehouse and Production data reporting
- SharePoint Online Documentation management and IAM management
- Using strong analytical and innovation skills for strategic planning, sound decision-making and problem solving while still working well under business driven deadlines
- Work with other department heads to design the IT workflow around concerns for the company's needs
- Oversee the administration, backup, securing, and managing of system accounts, storage allocations, user rights and access rights.
- Maintains good public relations and interacts with clients, customers, and co-workers in a respectful and professional manner.

- Administer all Tier 3 systems to support business needs
- Create/Manage Project plans for department members
- Plan IT Budgeting concerns and future business systems analysis/planning
- Disaster recovery planning and management
- Design and Implement over 98% of physical hardware into VMware cluster environment over 2 sites
- Oversea and manage over 200 + VM's in production and validation clusters across 10 sites and expanding to international support.

Senior System Administrator-Infrastructure, ICTSI Oregon   (02/17/2014-08/01/2015)
- (DDX) Assess issues with current network and discuss solutions for better flow
- Design and create a slipstream infrastructure that promotes efficiency and better functionality
- Design/manage 3 Virtual vCenter Clusters across 2 sites and 3 buildings in a 24x7 working environment
- Azure AD, O365 implementation and design
- RHEL, Ubuntu Server and Centos monitoring server management
- Manage VSAN and SAN storage arrays
- Monitor and design new Cloud Applications (O365, SharePoint Online)
- Administer all systems (Microsoft Server 2008-2012, Linux, Virtual Cluster, SCCM 2012
- Monitor changes in network infrastructure and plan for disaster recovery, network implementation updates

Information Technology Instructor, ITT Technical Institute   (02/01/2015-08/01/2015)
- Instructed students through their Associates' degree program for Computer Network Systems
- Held discussion, presentations and exercise to help learn "real world" examples and problems to further their learning experience.
- Professor in teaching VMware, Vsphere, vCenter, ESXi, physical environments and design implementations

Systems Administration II, Bonneville Power Administration (ie Solutions)   (08/01/2013-02/01/2014)
- Acted as System Administrator for BPA's Business Intelligence, Data Reporting and Integration Systems. Ensured all production systems were maintained and developed new designs to improve workflows and automate processes.
- Lead a team of 12 BI Developers to prioritize projects and meet business demands in relation to the budget constraints.
- SharePoint development and administration on enterprise intranet and configuration changes with SSRS, SSIS and Oracle Hyperion servers were a part of daily tasks. Heavily involved in working with Oracle and Microsoft representatives to improve the BI network.

Server and Network Design Specialist/Product Support Engineer – Huron Consulting (08/01/2011 -08/01/2013)
- Managed 600-800 ESXi VM's servers between 200+ physical servers to support development, test and production environments
- Serve as the primary liaison between customers and IT to ensure the successful delivery of IT solutions, providing production support to business users at all levels and providing user training on new SAP functionalities and other new applications
- Serve as a member of international service, specializing in client network design and implementation of our "Click Commerce Management" software
- Successfully implemented a new network design plan to streamline Huron's network and serve part of a support team managing issues and setting up servers builds for SAP management software
- Manage the ESXi environment, and create more efficient designs for client environments

- Coordinated projects with other team members to fulfill client needs in a timely fashion

Network Administrator

PACE Engineering, Inc - Portland, OR November 2009 to July 2011

- Managed the corporation's network of over 100 users, maintaining functionality and monitored servers.
- Management and development of SharePoint Intranet site.
- Monitored Symantec Enterprise environment for Backup and disaster recovery, ensuring the
- Corporation was secure for operations.
- Generated cost proposals and analyst documents on testing hardware/software when needed.

Education
Online 2018 - 2018

AWS Cloud Solutions Architect, AWS Cloud Management

ITT Technical Institute, Portland, OR
- Bachelors in Data Communications and Systems Technology, 2010-2011 (GPA 3.95)
- Associates of Applied Science-Computer Networking Systems, 2008-2010 (GPA 3.95)

Lane Community College, Eugene, OR
- Certified Licensed Massage Therapist 2003-2005

Umpqua Community College, Roseburg, OR
- Coursework, Electrical Apprentice, 2000-2001

Certifications and Training
AWS Certified Cloud Practitioner - Amazon Web Services April 2018

AWS and VMware SDDC Workshops

VMware Data Center Virtualization Certification programs:
- VCA6-DCV VMWare Certification
- VCP6-DCV VMWare Certification

CCNA Training

Converge Technology Solutions

North American Leading IT Solutions Provider

North American Footprint
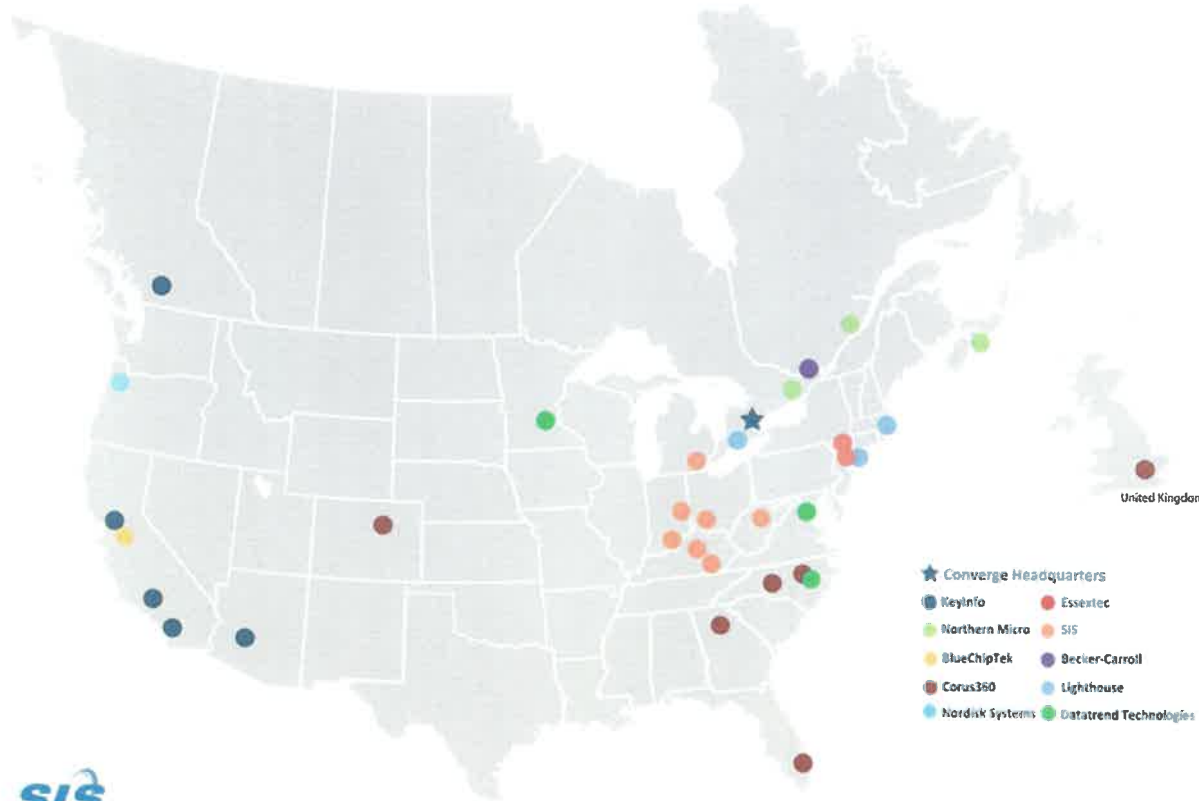
700 employees in US
80 employees in Canada

220+ engineers
170+ direct sales professionals
30 offices

United Kingdom

★ Converge Headquarters
● KeyInfo   ● Essextec
● Northern Micro   ● SIS
● BlueChipTek   ● Becker-Carroll
● Corus360   ● Lighthouse
● Nordisk Systems   ● Datatrend Technologies

SIS

▶ CONVERGE

Partners

Technology Partners

CISCO	IBM	DELL EMC	vmware
Microsoft	NetApp	redhat	aws
PURESTORAGE	Hewlett Packard Enterprise	Lenovo	paloalto
F5	Cameo GLOBAL	BROCADE	rubrik
NUTANIX	veeAM	FORTINET	HITACHI
FUJITSU	Zerto	EXAGRID	

SIS

Distribution Partners

INGRAM MICRO	Tech Data
SYNNEX CORPORATION	ARROW

CONVERGE

NetApp HCI Benefits for West Virginia Lottery

NetApp HCI feature overview

NetApp

Enterprise Scale by Design

Benefits of a node-based, shared-nothing architecture

- Any mix of storage and compute once base of two compute and two storage is achieved
- Add and remove nodes live in production
- GPU nodes available for VDI or specialized applications

Nondisruptively
(with enterprise-scale)

Grow as needed
(on demand)

Start small
(two chassis)

Future-proof your investment

Eliminate migrations and forklift upgrades

Never wait three years for an upgrade
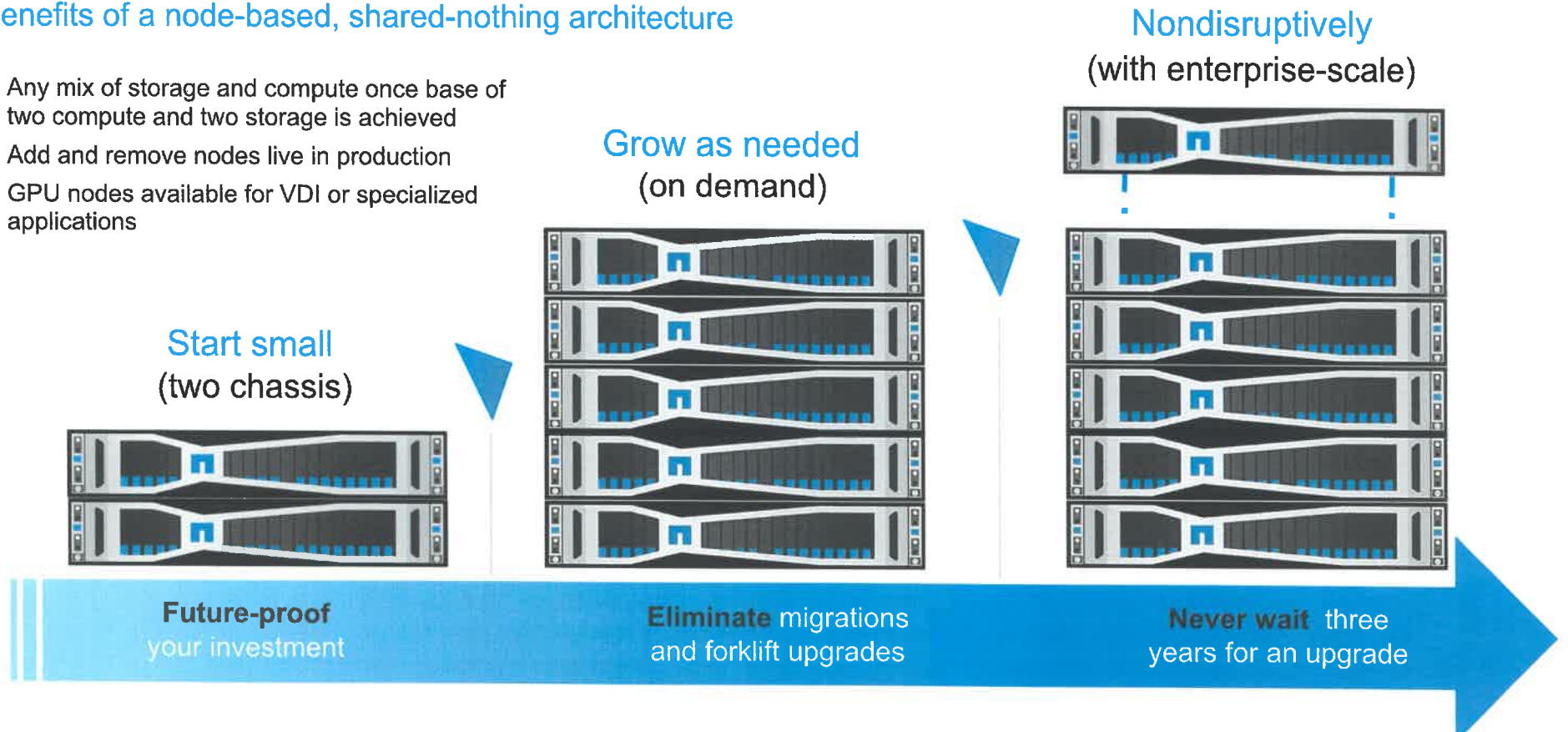
NetApp

Scale Compute and Storage Independently

Only purchase what you need. NetApp HCI doesn't force you to purchase both compute and storage capacity if you only need one or the other. This lowers TCO and licensing cost for core license-based applications like VMWare, SQL and Oracle.

| PERFORMANCE | CAPACITY | MEMORY | CPU |
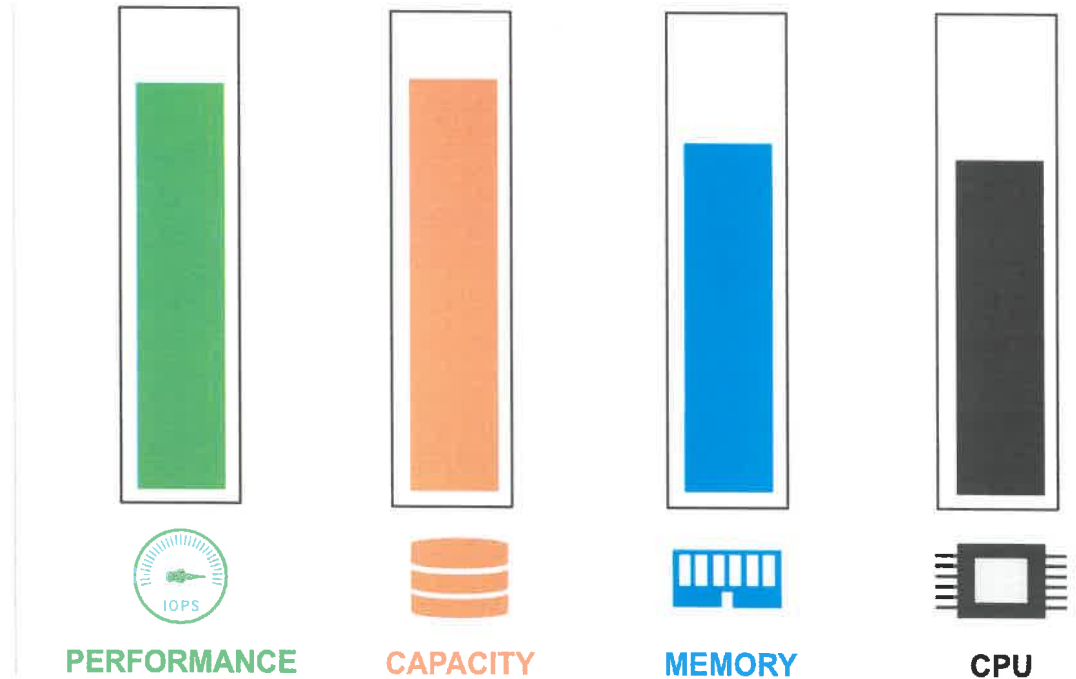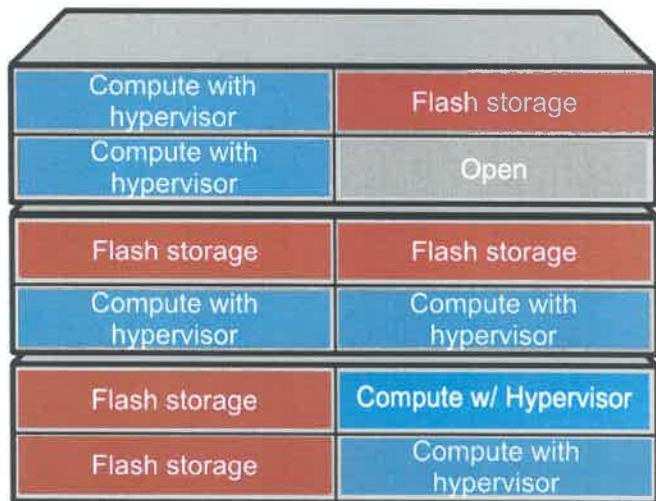
NetApp

NetApp Licensing TCO Comparison to VxRAIL

Since NetApp is a storage company and we own our storage operating system, we don't need VMWare or VSAN to create a storage environment for NetApp HCI. As such you don't pay the Hypervisor tax for licensing on cores or sockets associated with the storage like you do on VxRAIL

This example shows your solution where you have 2 x sockets of 20 cores each to run VSAN, the additional cores and sockets to run the applications below with VxRAIL would cost West Virginia Lottery an additional $683,771 in licensing compared to the cost of NetApp HCI

	Cores	Sockets		Application	List	License Method	Discounted	Additional Cost Per Node VxRAIL	Additional Cost Per Node NetApp HCI
Additional CPU for VSAN	40	2	Yes	vSphere Enterprise Plus	$ 5,700	per socket	$ 1,425	$ 2,850	0
Discount	75%		Yes	Microsoft Datacenter Enterprise	$ 6,155	per core	$ 1,539	$ 61,550	0
			Yes	SQL Server Enterprise	$ 14,256	per core	$ 3,564	$ 142,560	0
			Yes	Oracle Enterprise Edition	$ 47,500	per core	$ 11,875	$ 475,000	0
			Yes	RHEL Premium	$ 7,244	per 2-socket pair	$ 1,811	$ 1,811	0
							Total	$ 683,771	$ 0.00

NetApp

Open Storage Model

Flexibility to integrate external compute systems with NetApp HCI storage targets – Allows you to mix or change hypervisors as well as include bare metal nodes as needed for ultimate flexibility and lower cost

Other compute platforms

NetApp® HCI

Container volumes

VMware VVols

OpenStack volumes

KVM volumes

NetApp
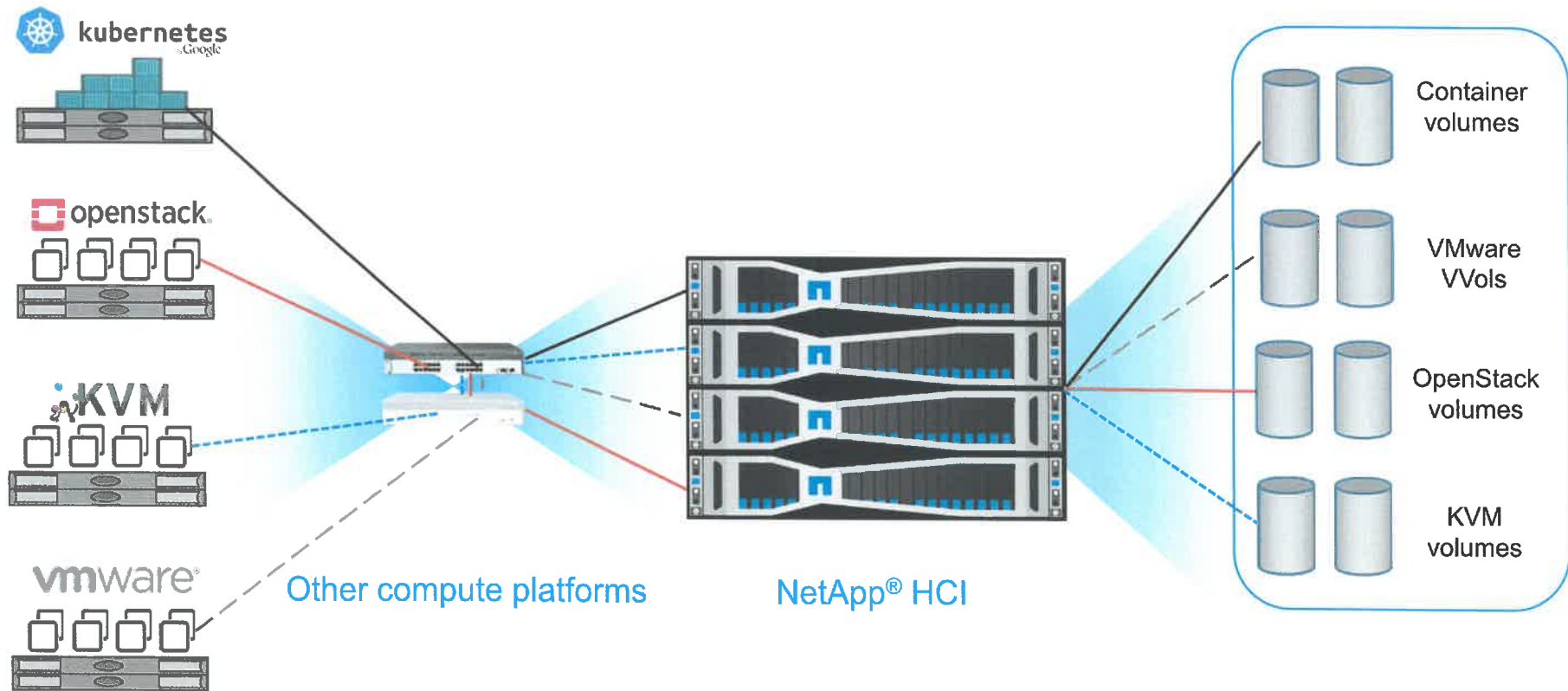
VMware vCenter Integration for ease of management

■ NetApp
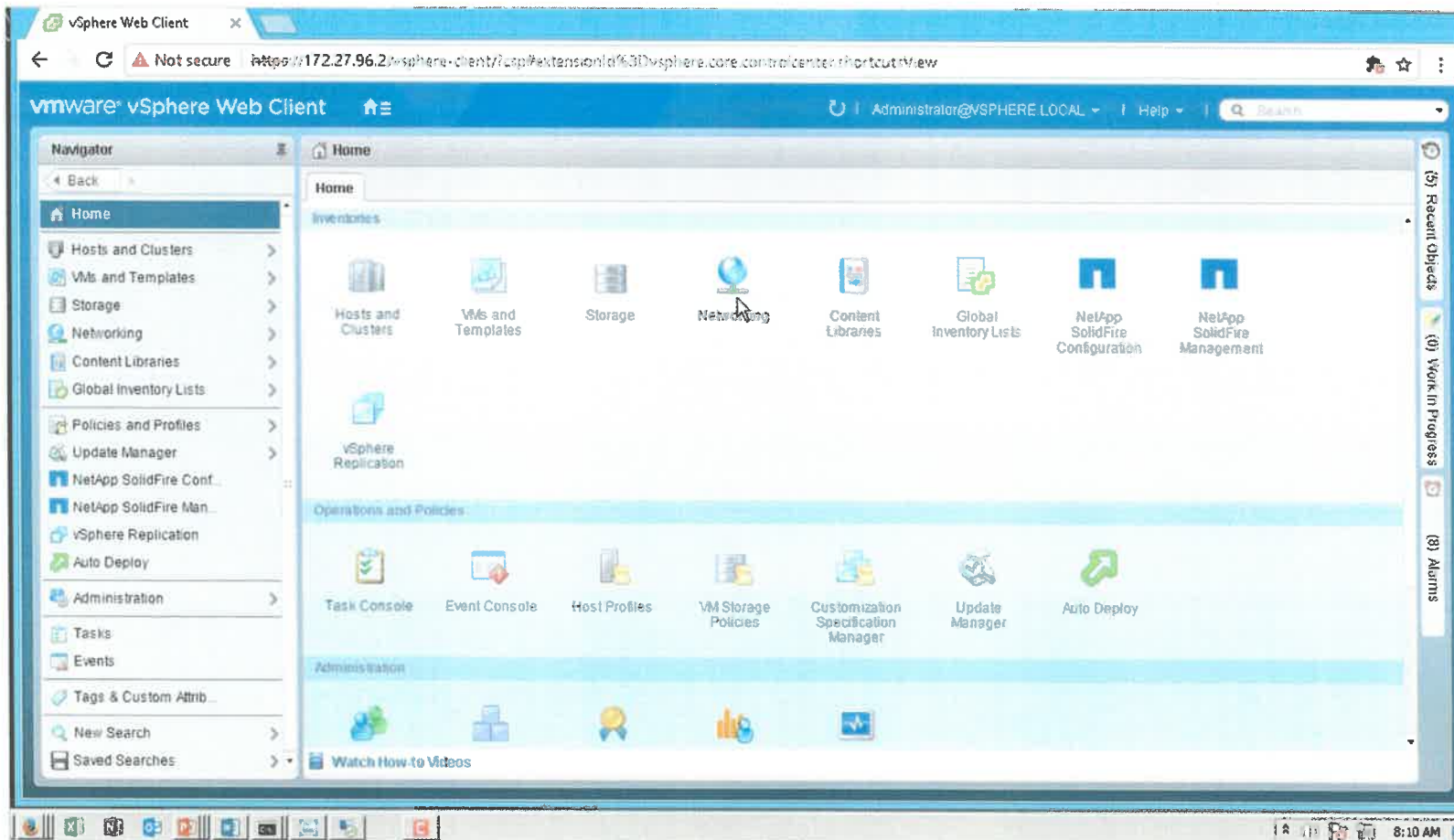
Network Virtualization with VMware NSX

The core of any fully functional private cloud solution

- Extends the capabilities of the virtual distributed switch

- In-kernel and fully distributed model scales

NetApp
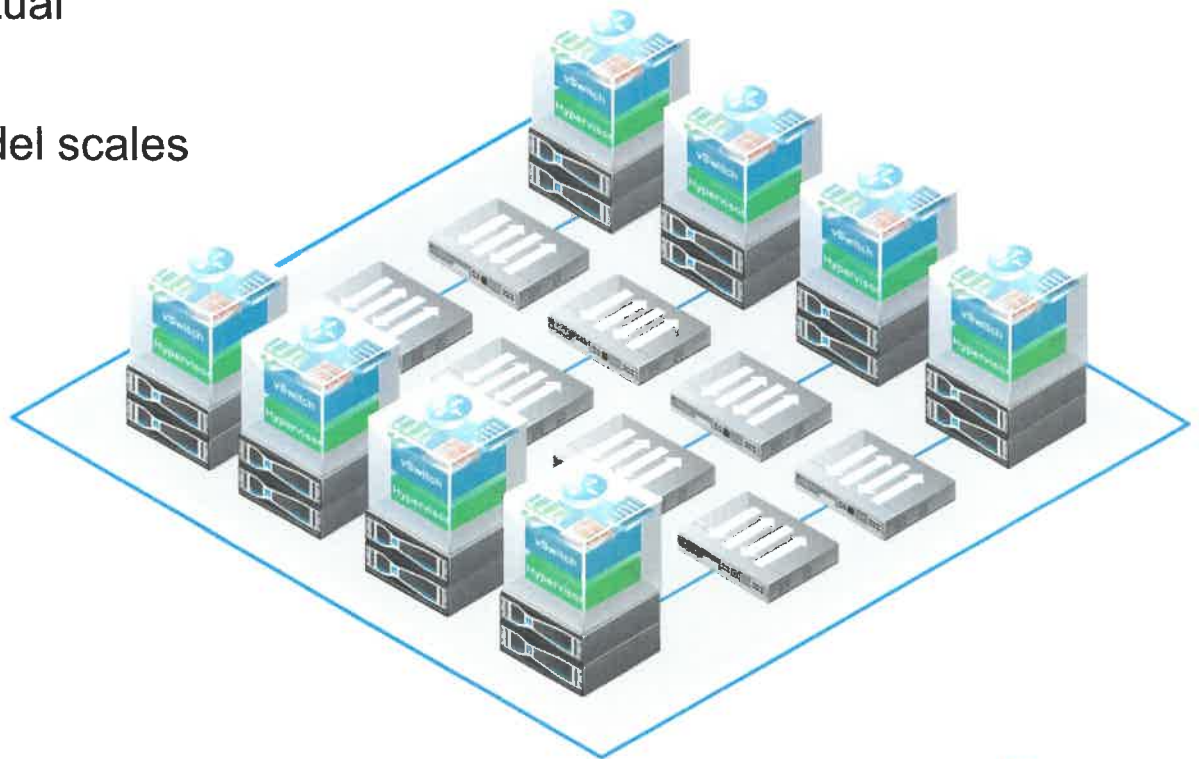
Network Virtualization

Attach your VMs to virtual networking constructs

- Network hypervisor
- Virtual data centers

NetApp
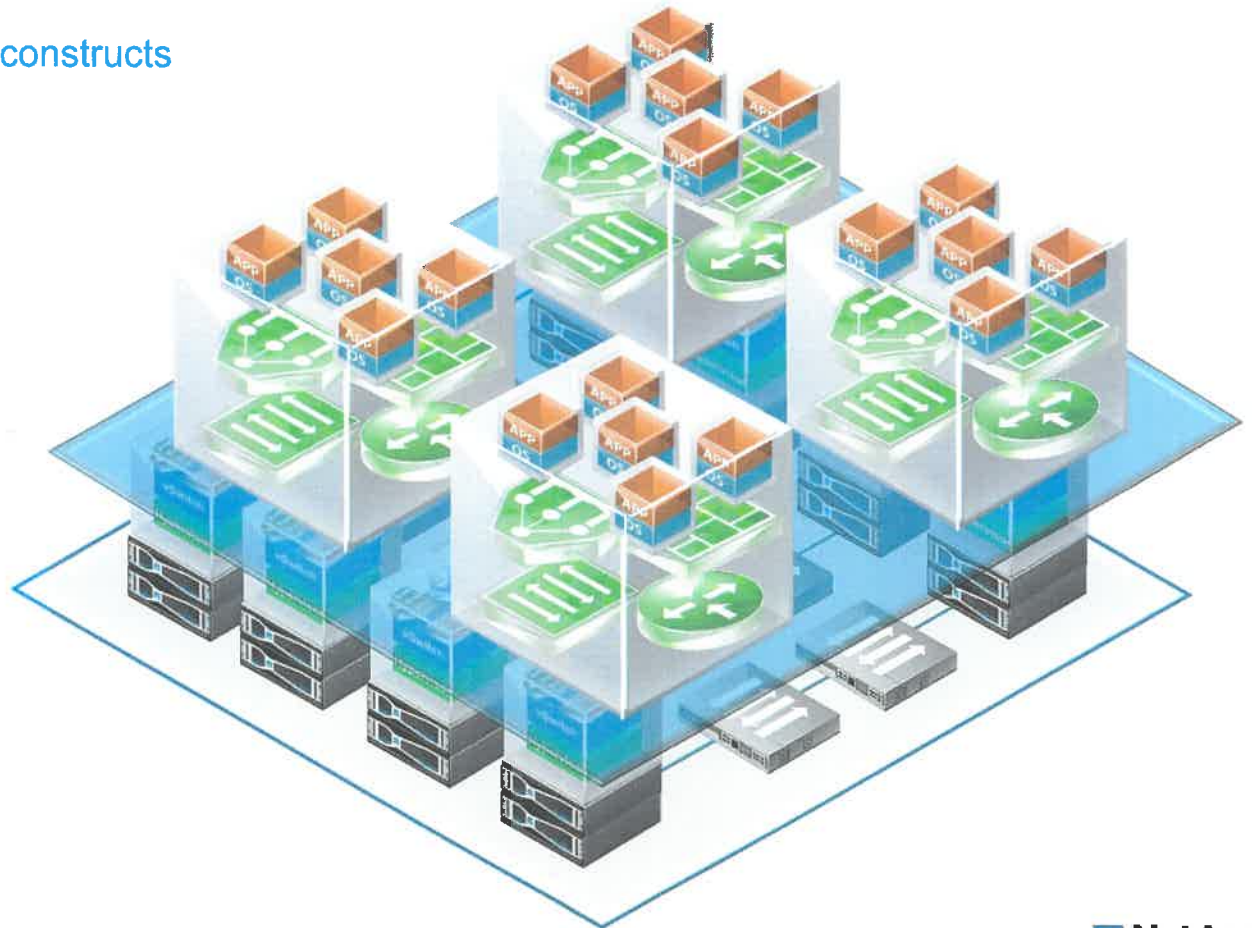
Predictable Performance

Eliminates noisy neighbors - QoS settings eliminate resource contention and each volume on the system gets its own minimum, maximum, and burst settings providing predictable performance for each application

As overall utilization increases…
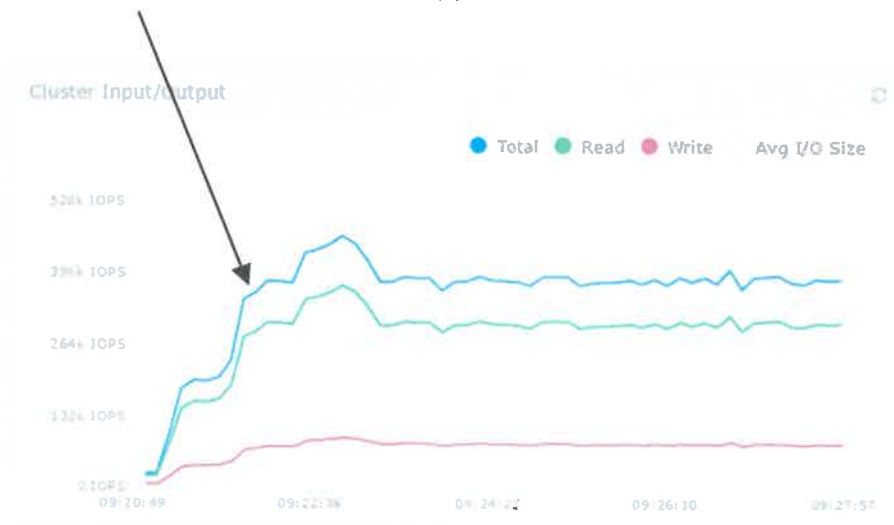
Min IOPS	✓	15,000
Max IOPS		20,000
Burst IOPS		25,000

…application IS protected due to correct guaranteed performance minimum

NetApp

NetApp HCI... Taking the "Con" Out of Hyperconverged

Enterprise-scale infrastructure

Guaranteed performance

Deliver all your applications
with confidence

Flexibility and scale

Scale on
your terms

Automated infrastructure

Transform and empower
your IT operations

Enterprise IT
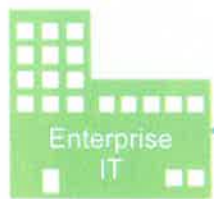
NetApp®
Data Fabric

NetApp
Data Fabric

Multicloud

Public cloud
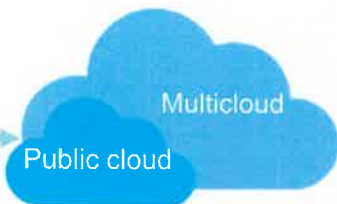
NetApp

Why NetApp HCI

1. **Independent Scale:** Maximize resources and minimize hypervisor tax. Grow IT based on business needs, not architectural deficiencies

2. **Workload consolidation:** No more silos, No more unnatural workload constraints. More VMs per dollar. More secure data. Better QoS, dedicated performance and guaranteed service levels. Ability to set minimum performance guarantee as well as a maximum limit

3. **Open hybrid multi-cloud:** No cloud lock-in. Consistent IT consumption across public cloud, private cloud and on-premises.

4. **Guaranteed efficiency:** The industry's most effective storage efficiency guarantee with no impact to system performance.

5. **End-to-End automation:** Zero learning curve. Use VMware deployment and management tools you already know. And don't waste time and money on additional proprietary software.

6. **Simplicity:** Easily support your virtualized environment as is. NetApp HCI is transparent and does not require changes to policies or procedures.

7. **Proactive protection:** Monitor, troubleshoot and optimize your entire infrastructure with NetApp Cloud Insights. Prevent issues early and accelerate resolution with NetApp Active IQ.

8. **Built in backup capabilities:** Replicates with NetApp SnapMirror replication to OnTap systems for no cost backup

9. **Lower TCO:** Lower TCO by not having to pay for VMWare or Application licensing for the cores that are running storage. Only pay for licensing associated with compute nodes.

10. **Multi Hypervisor capable:** VMware, Hyper-V, OpenStack,VMware clusters, Docker options allow you to mix and match hypervisors and use what fits your needs best even if your needs change over time.

■ NetApp

Why NetApp?

1. **NetApp Efficiency:** On average, NetApp customers require 50% less storage than their current storage solution. NetApp guarantees 3:1 efficiency on Flash

2. **NetApp Longevity:** NetApp, the largest publicly traded data management company in the world, is not a startup, and has been in business since 1992. You can rest assured that we will not only be here to support your business now, but in the future.

3. **#1 Federal Government Market Share:** NetApp is the largest provider of storage to the US Federal Government with an estimated 50% market share in Civilian Federal and an estimated 70% share in Secure Federal, more than all other data storage vendors combined. This is mainly due to NetApp's unique security capabilities which are utilized to protect sensitive government data.

4. #1 Storage OS Market Share: International Data Corporation (IDC) Storage Hardware and Software Market Share shows that NetApp Data ONTAP® is the world's number one storage operating system.

Ranked #1 in Revenue
Top 5 Branded Storage OS
2018 Q2 Worldwide Open Networked
Revenue Market Share

Ranked #1 in Capacity Shipped
Top 5 Branded Storage OS
2018 Q2 Worldwide Open Networked
Capacity Market Share
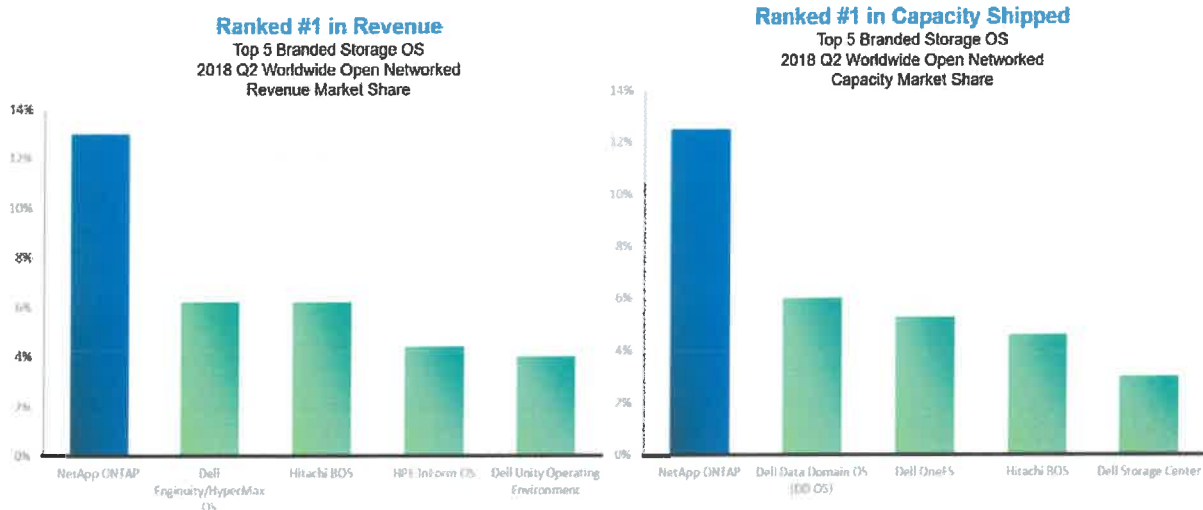
5. **#1 Converged Infrastructure, FlexPod:** NetApp, in partnership with Cisco created FlexPod, the world's #1 converged infrastructure solution. IDC ranks FlexPod #1 in their latest quarterly Tracker on the Worldwide Integrated Infrastructure and Platforms market. FlexPod is also ranked #1 in customer satisfaction per 451 independent research.

6. **#1 NetApp is the worlds fastest growing HyperConverged solution provider.**

7. **#1 NetApp E-Series: E-Series is the world's #1 deployed storage hardware product in history.** With over 1 Million controllers shipped, there is no other SAN storage product that has sold more. NetApp E-Series powers the world's largest data warehouse, the world's largest contiguous file system at Lawrence Livermore National Labs, powers 5 of the top 10 most powerful supercomputers in the world and is used in many of the worlds largest video surveillance and backup infrastructures.

8. **#1 in Flash Growth:** NetApp's AFF product achieved NetApp grew 300.6% Year over Year 3.2x faster than the market growth of 94.5% Year over Year.

9. **#1 Gartner Storage Product: Gartner's latest magic quadrant for primary storage has NetApp positioned in the highest section of the leaders quadrant.**

10. **#1 Cloud Storage Option provider.** NetApp partners with all major cloud providers and has more cloud compatible storage options than any other vendor. Compare the search results of NetApp and any other storage provider in your favorite cloud providers catalog and see for yourself.

11. **#1 Object Store.** NetApp StorageGrid is the top featured Object Store according to Gartner.

12. **#1 NVIDIA** - NetApp is NVIDIA's worlds largest storage partner for AI/ML Computing.

IDC Also shows NetApp AFF/FAS was #1 in scale-out NAS
IDC WW Quarterly Enterprise Storage Systems Tracker, 2019 Q1, June 6, 2019 – Vendor Revenue

Figure 1. Magic Quadrant for Primary Storage

Source: Gartner (September 2019)

NetApp recognized as a *Leader* in 2019 Gartner Magic Quadrant for Primary Storage

This Magic Quadrant was published as part of a larger research note and should be evaluated in the context of the entire report. The full report is available from NetApp.

https://www.netapp.com/us/campaigns/gmq-primary-storage-report/index.aspx

Datasheet

NetApp HCI

Enterprise-scale hybrid cloud infrastructure

Key Benefits

Reduce Consumption Costs

- Consolidate multiple workloads and reduce TCO by 59%
- Pay less as you grow more
- Remove or reduce infrastructure capex
- Avoid the hypervisor licensing tax

Flexible

- Hybrid cloud, one infrastructure
- Dynamically scale up and/or down
- Leverage existing investments and redeploy

Simple

- Easy to deploy with NetApp® Hybrid Cloud Control manageability suite
- Common experience across public and private clouds
- Integrated with data fabric powered by NetApp
- 92% less administrative time with nondisruptive scaling and no downtime
- Centralize and streamline management

Accelerate New Services

Public cloud providers offer a simple, fast, and efficient model to consume required IT services and help optimize budgets. However, organizations still need the other half of the hybrid model: creating, securing, and deploying services for on-premises environments based on business, compliance, and operational requirements. These requirements are leading IT organizations to demand equivalent cloud-native IT services for on-premises data centers. Public clouds automate management and lifecycle, and they simplify how users consume IT. Although hyperconverged infrastructures originally sufficed, their design neglects the ability to span and scale a choice of resources across the data center and multiple public clouds. NetApp HCI delivers an elastic hybrid cloud infrastructure that enables customers to start anywhere, run anywhere, and manage everywhere.

Streamline Infrastructure and Maximize Your Clouds

NetApp HCI is designed to deliver a public cloud consumption experience with simplicity, dynamic scale, and operational efficiency to hybrid multiclouds. NetApp HCI is built to seamlessly orchestrate containers on the premises. Infrastructure and cloud architects can easily access industry-leading services from any third-party cloud provider, run them on their premises, and mix and match these services to optimize resources for specific workloads and applications.

Empower your organization to move faster while reducing costs with NetApp HCI. Easily manage and run multiple applications with the predictable performance that your enterprise and customers demand. Scale compute and storage resources independently so you never pay for more than you use. And deploy in minutes with a turnkey cloud infrastructure that eliminates the complex management of traditional three-tier architectures. Integration into the data fabric delivered by NetApp means that you can unleash the full potential of your applications, with the data services they require, across any cloud.

Break free from the limits of today's hyperconverged infrastructure solutions that are complex, can't consolidate all of your workloads, force you to scale in ways that strand resources, and throttle the performance required by next-generation applications. Realize the true promise of an enterprise-scale hybrid cloud infrastructure solution with NetApp HCI.

∎ NetApp®

Increase Operational Efficiency and Customer Satisfaction

One of the biggest challenges in any data center is to deliver predictable results, especially in the face of proliferating applications and workloads. Any time that multiple applications share the same infrastructure, the potential exists for one application to interfere with the performance of another. NetApp HCI solves predictability challenges with unique performance guarantees that provide granular control of every application, eliminating resource contention, delivering 3 times the storage performance1, and increasing compute efficiency by 22%1.

One of the most effective ways for enterprise customers to take advantage of the NetApp HCI performance guarantees is by consolidating all of their applications, including ones that previously required separate silos. In NetApp HCI, each volume is configured with minimum, maximum, and burst IOPS values. The minimum IOPS setting guarantees performance, independent of what other applications on the system are doing. The maximum and burst values control allocation, enabling the system to deliver consistent performance to all workloads.

Dynamically Scale on Demand to Lower TCO

Data centers don't scale linearly because business needs are constantly changing, and each application requires different things from the infrastructure. The NetApp HCI node-based shared-nothing architecture delivers independent scaling of compute and storage resources. This approach enables you to dynamically scale up or down on demand, avoiding costly and inefficient overprovisioning and simplifying capacity and performance planning. Start as small as two nodes and add exactly what you require to scale your infrastructure in a granular fashion over time to reduce TCO. Third-party analysis shows that NetApp HCI is the lowest-cost all-flash HCI on the market today, reducing TCO by as much as 59%1.

Most companies don't want to throw away their existing data center investments when purchasing new equipment. NetApp HCI has an open and flexible architecture that lets you use your existing virtualization infrastructure, licenses, and external compute to lower initial acquisition costs and repurpose existing operations.

Simplify and Automate to Empower Your Business

NetApp HCI streamlines installation through an intuitive deployment engine that has automated more than 400 inputs to fewer than 30 to get you running in about 45 minutes. In addition, a robust suite of APIs enables seamless integration into higher-level management, orchestration, backup, and disaster recovery tools. And with the NetApp Hybrid Cloud Control management suite, you can manage, monitor, and upgrade your entire infrastructure throughout its lifecycle through a single pane of glass.

NetApp HCI offers a choice of centralized management through VMware, Red Hat, and OpenStack to give you control through tools you already use, so that you can focus your resources on higher priorities that drive business growth. NetApp HCI delivers a true hybrid multicloud experience.

Unleash the Power of Your Data to Achieve a New Competitive Advantage

Leading businesses across every industry are building data fabrics to strategically address today's complex IT challenges: modernizing and simplifying IT to accelerate business-critical applications, building private cloud to gain speed and agility, and fueling data-driven innovation on their choice of clouds. Organizations that are doing any of these things with NetApp are on their way to building their unique data fabric. The data fabric is NetApp's strategy for simplifying and integrating the orchestration of data services for enterprise and cloud-native applications in any combination across hybrid multicloud environments. The data fabric enables companies to respond and innovate more quickly because their data is accessible from both on-premises and public cloud environments. Integration with the data fabric allows NetApp HCI to provide data services, including file services, through NetApp ONTAP® Select, object services through NetApp StorageGRID®, replication services through NetApp SnapMirror®, data visibility through NetApp OnCommand® Insight, and backup and recovery services through NetApp Cloud Backup.

NetApp HCI: Multicloud Enterprise Scale

NetApp HCI is composed of industry-leading technologies that are integrated to deliver a hybrid cloud infrastructure that addresses enterprise-class multicloud agility, scale, and services. It brings together Intel core processing for system-critical applications, networking for hyperconverged infrastructures, and the industry's highest user density for virtualized desktops and applications from NVIDIA's GPUs. All parts of the infrastructure are fully architected and managed as a single appliance, through a single pane of glass.

- NetApp's innovative three-dimensional quality of service offers predictable performance across all of your applications.
- Independent compute and storage resources allow you to scale flexibly when and how you need to.
- Simplified deployment and ongoing management give your IT department an automated infrastructure from day 0 to day 1,500 and beyond.
- You have freedom of choice. Whether you use VMware or Red Hat private cloud stack, or connect containerized workloads to your public cloud vendor, NetApp HCI delivers an agile foundation for your private and hybrid cloud infrastructure.

As your business adopts a hybrid multicloud approach, you'll need to create your own perfect world, with some data stored in the public cloud and other data stored on your premises. NetApp HCI is architected to deliver cloud-native capabilities that extend from the data center into the public cloud vendor. Leverage the full potential of your data, whether on your premises or in the public cloud, through integration with your data fabric.

Start Your Transformation Today

Our data experts are available to help you plan and implement your seamless transition to NetApp HCI and gain advantages from day 1. You can use NetApp Services or NetApp Services Certified Partners; you can do it yourself by using our proven tools and processes; or you can combine these approaches.

Figure 1) H410C/S compute and storage node.

Figure 2) H610C graphic compute node.

Figure 3) H610S storage node.

Figure 4) H615C compute node.

NetApp HCI Specifications

Key Specification

Compute Nodes	H410C	H610C[1]	H615C
Rack Units	2 RU, half-width	2 RU	1 RU
CPU/GPU	2 Intel Xeon Gold 5122, 4 cores, 3.6GHz 2 Intel Xeon Silver 4110, 8 cores, 2.1GHz 2 Intel Xeon Gold 5120, 14 cores, 2.2GHz 2 Intel Xeon Gold 6138, 20 cores, 2.0GHz	2 Intel Xeon Gold 6130, 16 cores, 2.1GHz 2 NVIDIA Tesla M10 GPU cards	2 Intel Silver 4214, 12 cores, 2.2 GHz 2 Intel Gold 5222, 4 cores, 3.8 GHz 2 Intel Gold 6242, 16 core, 2.8 GHz 2 Intel Gold 6252, 24 core, 2.1GHz 2 Intel Gold 6240Y SpeedSelect, 18/14/8 cores 2.6/2.8/3.1 GHz plus 3 NVIDIA Tesla T4 GPU cards
Cores for VM's	8 - 40	32	8 - 48
Memory	384GB - 1TB	512GB	384GB - 1.5TB
Hypervisor	VMware vSphere 6.5 and 6.7; Red Hat OpenStack/OpenShift		
Base Networking	4x 10/25GbE (SFP 28)², 2x 1GbE RJ45	2x 10/25GbE (SFP 28)², 2x 1GbE RJ45	2x 10/25GbE (SFP 28)²
Out-of-Band Management (optional)	1x 1GbE RJ45		

Storage Nodes	H410S	H610S	H610S-2F
Rack Units	2 RU, half-width	1 RU	1 RU
SSD	6 Encrypting or nonencrypting	12 Encrypting or nonencrypting	12 Encyrpting or nonencryptihng
Drive Capacity	480GB, 960GB, 1.92TB	960GB, 1.92TB, 3.84TB	960GB, 1.92 TB, 3.84 TB
Effective Capacity*	5.5TB - 44TB	20TB - 80TB	20TB-80TB
Performance per Node	50,000 IOPS - 100,000 IOPS	100,000 IOPS	100,000 IOPS
Base Networking	4X 10/25GbE (SFP 28)², 2x 1GbE RJ45	2x 10/25GbE (SFP 28)², 2x 1GbE RJ45	2 x 10/25GbE iSCSI (SFP28), 2 x 1/10GbE Mgmt. (RJ45)
Out-of-Band Management (optional)	1x 1GbE RJ45	1x 1GbE RJ45	1 x 1GbE RJ45

Power and Dimension

Chassis	H410x 2U 4 Node Enclosure	H610C	H610S	H610S
Rack Units	2 RU	2 RU	1 RU	1 RU
Power Input	220-240V AC 1+1 redundant	220-240V AC 1+1 redundant	110-240V AC 1+1 redundant -48-60V DC 1+1 redundant	110-240V AC 1+1 redundant -48-60V DC 1+1 redundant
Maximum Wattage/Current (per power supply)	2200W / 12-11A (fully populated enclosure)	819-1024W / 4.1-5.2A (200V)	450W / 2.2A (200V) / 4.5A (100V)	616-805W / 3-3.9A (200V) / 6.2-8A (100V)
Node Physical Dimensions	3.92cm / 1.54in H 19.625cm / 7.73in W 58.755cm / 23.13in D 4.17kg / 9.2lbs	8.80cm / 3.46in H 44cm / 17.3in W 79.8cm / 31.4in D 25kg / 55.1lbs	4.4cm / 1.73in H 44cm / 17.3in W 81cm / 31.9in D 18kg / 39.7lbs	4.4cm / 1.73in H 44cm / 17.3in W 81cm / 31.9in D 15.51-16.65kg / 34.20-36.71lbs
Enclosure Physical Dimensions Weight	8.80cm / 3.46in H 44.70cm / 17.60in W 73.00cm / 28.74in D 19.50kg / 43.0lbs (empty incl. rails) 36.2kg / 79.8lbs (fully populated)	8.80cm / 3.46in H 44cm / 17.3in W 79.8cm / 31.4in D 25kg / 55.1lbs	4.4cm / 1.73in H 44cm / 17.3in W 81cm / 31.9in D 18kg / 39.7lbs	4.4cm / 1.73in H 44cm / 17.3in W 81cm / 31.9in D 15.51-16.65kg / 34.20-36.71lbs

NetApp HCI Specifications, Continued

Environmentals	H410C/S	H610C	H610S	H615S
Operating Temperature, Altitude, and Relative Humidity	10°C to 35°C / 50°F to 95°F at <= 914.40m (at <= 3,000ft) elevation; 1°C derating per 1,000ft; 8% to 90% relative humidity, noncondensing	10°C to 35°C / 50°F to 95°F at <= 914.40m (at <= 3,000ft) elevation; 1°C derating per 1,000ft; 20% to 85% relative humidity, noncondensing		10°C to 35°C / 50°F to 95°F at <= 914.40m (at <= 3,000ft) elevation; 1°C derating per 1,000ft; 20% to 85% relative humidity, noncondensing. (: Note: Configurations containing Tesla T4 GPUs: 10°C to 30°C).
Nonoperating Temperature and Relative Humidity	-40°C to 70°C (-40°F to 158°F); 5% to 95% relative humidity, noncondensing	-40°C to 70°C (-40°F to 158°F); 10% to 90% relative humidity, noncondensing		
Heat Dissipation	Typical BTU/hr — 2,730 Worst Case BTU/hr — 6,142 (Fully populated enclosure)	Typical BTU/hr — 2,795 Worst Case BTU/hr — 3,494	Typical BTU/hr — 1,228 Worst Case BTU/hr — 1,535	Typical BTU/hr — 2,102 Worst Case BTU/hr — 2,747
Standards and Certifications	Safety: IEC/EN 60950 (all national deviations), UL/CSA 60950, IEC/ EN 60825, ACMA (Australia, New Zealand), BIS (India), BSMI (Taiwan), CE, EAC (Russia), IRAM (Argentina), Morocco, Mexico, NRCS (South Africa), Saudi Arabia, Kenya, Uganda, SONCAP (Nigeria), TBS (Tanzania), UKRSepro (Ukraine). FIPS-1424	Safety: IEC/EN 60950 (all national deviations), UL/CSA 60950, IEC/ EN 62368 (all national deviations), UL/CSA 62368, IEC/EN 60825, ACMA (Australia, New Zealand), BIS (India), BSMI (Taiwan), CE, EAC (Russia), IRAM (Argentina), Morocco, Mexico, NRCS (South Africa), Saudi Arabia, Kenya, Uganda, SONCAP (Nigeria), TBS (Tanzania), UKRSepro (Ukraine).	Safety: IEC/EN 60950 (all national deviations), UL/CSA 60950, IEC/ EN 60825, ACMA (Australia, New Zealand), BIS (India), BSMI (Taiwan), CE, EAC (Russia), IRAM (Argentina), Morocco, Mexico, NRCS (South Africa), Saudi Arabia, Kenya, Uganda, SONCAP (Nigeria), TBS (Tanzania), UKRSepro (Ukraine). FIPS-1424	Safety: IEC/EN 60950 (all national deviations), UL/CSA 60950, IEC/ EN 60825, ACMA (Australia, New Zealand), BIS (India), BSMI (Taiwan), CE, EAC (Russia), IRAM (Argentina), Morocco, Mexico, NRCS (South Africa), Saudi Arabia, Kenya, Uganda, SONCAP (Nigeria), TBS (Tanzania), UKRSepro (Ukraine). Energy Star
	Emissions/Immunity: FCC Part 15 Class A, ICES-03, CE, KCC, VCCI, AS/NZS CISPR 22, CISPR 32, EN55032, EN55024, EN61000-3-2, EN61000-3-3, BSMI			
Compliance	RoHS-compliant			

System Environment Specifications

	H410C/S	H610C	H610S	H615S
Operating Vibration	.4Grms, 5-200Hz random vibration 60 minutes per axis 3 mutually orthogonal axis	0.2Grms, 5-350Hz random vibration 15 minutes per axis 3 mutually orthogonal axes	0.21Grms, 5-500Hz random vibration 15 minutes per axis 3 mutually orthogonal axes	0.2Grms, 5-350Hz random vibration 15 minutes per axis 3 mutually orthogonal axes
Nonoperating Vibration	.98Grms, 5-200Hz random vibration 30 minutes per axis 3 mutually orthogonal axis	0.77Grms, 5-500Hz random vibration 30 minutes per axis 3 mutually orthogonal axes	1.04Grms, 10-500Hz random vibration 60 minutes per axis 3 mutually orthogonal axes	0.77Grms, 5-500Hz random vibration 30 minutes per axis 3 mutually orthogonal axes
Operating Shock	20G/2.5ms half sine profile 3 mutually orthogonal axis (Positive and negative directions) 1 shock pulse per direction	3G/11ms half sine input profile 3 mutually orthogonal axes (positive and negative directions) 3 shock pulse per direction	5G/11ms half sine input profile 3 mutually orthogonal axes (positive and negative directions) 100 shock pulse per direction	3G/11ms half sine input profile 3 mutually orthogonal axes (positive and negative directions) 3 shock pulse per direction
Nonoperating Shock	20G/10ms half sine profile 3 mutually orthogonal axis (Positive and negative directions) 1 shock pulse per direction	20G/7ms half sine input profile 3 mutually orthogonal axes (positive and negative directions) 3 shock pulse per direction	20G/11ms half sine input profile 3 mutually orthogonal axes (positive and negative directions) 3 shock pulse per direction	20G/7ms half sine input profile 3 mutually orthogonal axes (positive and negative directions) 3 shock pulse per direction

[1] NetApp HCI H610C/H615C with GPU requires NVIDIA Software License.
[2] Cables and transceivers not included.
[3] NetApp HCI effective capacity calculation accounts for NetApp Element software, NetApp SolidFire Helix[9] data protection, system overhead, and global efficiency, including compression, deduplication, and thin provisioning. Element software customers typically achieve an effective capacity range of 5 to 10 times the (usable) capacity, depending on application workloads.
[4] NetApp HCI supports the FIPS 140-2 level 1 standard. Third-party validation is in progress.

Mellanox H-Series Switches	
SN2010	Half-width open Ethernet switch with Mellanox Onyx. 18 SFP28 (10/25GbE) and 4 QSFP (40/100GbE) ports delivering up to 1.7TB/s aggregate throughput. QSFP ports support 4x25GbE breakout cables. Switch sold with all ports licensed.
SN2100	Half-width open Ethernet switch with Mellanox Onyx. 16 QSFP (40/100GbE) ports delivering up to 3.2TB/s aggregate throughput. QSFP ports support 4x25GbE breakout cables. Switch sold with all ports licensed.
SN2700	Full-width open Ethernet switch with Mellanox Onyx. 32 QSFP (40/100GbE) ports delivering up to 6.4TB/s aggregate throughput. QSFP ports support 4x25GbE breakout cables. Switch sold with all ports licensed.
Features	Mellanox Neo management application, monitoring, and telemetry, network virtualization, layer 2 and layer 3 support, management, and automation.
Security	UC APL, FIPS 140-2, Storm Control (ACLs L2-L4 and user defined), 802.1X – Port-Based Network Access Control, SSH server strict mode – NIST 800-181A, CoPP (IP filter), port isolation.

NetApp HCI is backed by world-class support, with a single point of contact for both hardware and software. Support includes 24/7/365 worldwide availability, with 4-hour on-site response for critical system issues.

For more information, visit www.netapp.com.

About NetApp

NetApp is the leader in cloud data services, empowering global organizations to change their world with data. Together with our partners, we are the only ones who can help you build your unique data fabric. Simplify hybrid multicloud and securely deliver the right data, services and applications to the right people at the right time. Learn more at www.netapp.com.

COCA-COLA | PROBLEM SOLVED

The Coca-Cola Central Bottling Co. (CBC) of Israel installed two HCI systems—one DMZ unit and another for its dairy production plant–to reduce latency and guarantee performance. Building on that success, the CBC installed a third system to handle its Citrix VDI needs.

Coca-Cola Central Bottling Co. Improves Efficiency and Performance with HCI

The Coca-Cola Central Bottling Co. (CBC) installed two NetApp HCI systems-one at their DMZ center and another at their dairy plant– enabling the company to respond quickly to market changes and customer demands. Drastically cutting the CBC's data center footprint, HCI enhances performance, improves efficiency, and slashes costs to help the company meet the needs of its rapidly growing markets. After a short time, the CBC installed a third HCI system for Citrix VDI workloads.

50% Hardware and electricity cost savings

90% Footprint reduction

27x Higher efficiency

1-2- Day system deployment

GUARANTEED PERFORMANCE

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Luciano Ludwig
Former Senior IT Systems Solution Architect, CBC

The CBC is the number one beverage producer in Israel. In addition to Coca-Cola branded soft drinks, the CBC manufactures a range of alcoholic and non-alcoholic beverages. The company also owns several food-manufacturing plants, including Tara, Israel's largest dairy producer. The CBC maintains an extensive distribution network that ensures on-time and on-spec delivery of its high-quality products to tens of thousands of retailers throughout the country.

As Israel's beverage and dairy sectors continued to expand and become more competitive, the CBC recognized that its compute and storage systems were preventing a rapid reaction to market changes and customer requirements. "Our servers at our production plant kept on falling and our daily backup and restore capabilities were ineffective due to extremely high latency," says Luciano Ludwig, former senior IT systems solution architect for CBC.

"This combination slowed down not only our application development, but also our manufacturing and distribution activities. We spent a year or two looking for hyperconverged technologies that could help us become more efficient and agile. After checking out several vendors and even starting a pilot with one, we still felt that we didn't have the right answer. Soon after NetApp introduced HCI, however, I had the chance to see it at work in a lab setting, and immediately decided that it was exactly what we needed."

The CBC was so impressed with NetApp® HCI that it ordered two systems to simplify and automate its virtualized workloads and build a suitable cloud-based infrastructure. The first system was for the CBC's customer-facing DMZ unit, the second for Tara's production plant.

"All of our customer engagement–be it ordering, billing, payments–is done through the DMZ, so it's essential that it operates 24/7 throughout the year," Ludwig says. "At the same time, to keep up with growing customer demand for our dairy products, the Tara plant needs to function round-the-clock, otherwise, we'll suffer losses."

INSTALLING THE SYSTEM IS A BREEZE

Over one weekend in March, NetApp installed the HCI system, comprised of 4 H500S storage nodes and 4 H700E compute nodes, at Tara's data center in the south of the country. The following weekend, NetApp did the same for the DMZ data center in the north, this time installing 4 H500S storage nodes and 2 H700E compute nodes.

"Getting the systems installed and up and running was a breeze," Ludwig says. "It took us just one hour to configure everything, and then we plugged the HCI into our VMWare environment and it's been working flawlessly ever since. Everything within our data centers–SQL, Exchange, SAP, databases–integrates into HCI, and system management is automated and simple. For us, it was set it and forget it."

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Luciano Ludwig
Former Senior IT Systems Solution Architect, CBC

LOWERING LATENCY TO DELIVER GUARANTEED PERFORMANCE

The greatest impact that NetApp HCI has had on the CBC's data centers is guaranteed performance, which touches not only the company's 250 VMs and 3,000 users, but also tens of thousands of customers. "Our previous system's performance was poor, and it was affecting our operations and customer interaction," Ludwig says. "After we installed HCI, all of our performance issues disappeared.

"Our biggest problem, latency, dropped drastically from 120 milliseconds to 1 millisecond, IOPS increased to 50,000, and system uptime reached 100%. We can restore with NetApp's SnapShot in minutes rather than hours. We generate production reports within hours rather than a day. And we fully utilize our VM environment. If anything, now our system is over-performing, and we can grow without thinking twice about it."

Because of the CBC's initial success with the first two NetApp HCI systems, the company installed a third system to improve the performance of its Citrix virtual desktop infrastructure (VDI) workloads. The CBC's 6,000 internal Citrix users were experiencing 20-second wait times for completion of VDI tasks. NetApp HCI performance reduced the wait time by more than half.

REDUCING FOOTPRINT BY 90%

HCI has also led to a significant reduction in footprint at the CBC's data centers. "Before HCI, we had two rack cages comprised of two server enclosures of 8u, an additional two storage nodes plus shelving of 6u," Ludwig says. "With HCI, we've been able to put everything into one rack cage of 4u. As such, we've been to slash our footprint from 42u to 4u."

And when it comes to storing efficiency, HCI has done the job. Each HCI system includes a 20TB storage system that enables provisioning of 25-30TB at an effective capacity of over 260TB. By improving thin provisioning, deduplication and compression efficiency, HCI delivers 27 times better overall efficiency at each data center.

CUTTING HARDWARE COSTS BY 50%

The CBC has also enjoyed significant cost savings since the arrival of NetApp HCI. "We've reduced our hardware and electricity costs by 50%, and have also cut down on licensing costs," Ludwig says. "Moreover, since the system is automated and easy to use, I don't have to allocate any manpower to ensure that things are working, that daily backup reports are being produced. Now the staff can focus on what they're good at, rather than addressing the continuous bottlenecks and problems we had been experiencing."

Even though the CBC has required little to no support from NetApp

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since installing HCI, Ludwig can't say enough about how the company has been much more than a typical vendor, or for that matter, a typical partner.

"It's hard for me to explain just how much NetApp means to us," he says. "From our first discussions about HCI until today, NetApp personnel have treated us like family. Unlike other vendors, NetApp speaks with actions, not words. They've delivered on every promise they made. They've created a special bond by working together with us to determine what's right for both sides. And if I ever have a question or need something done,

there's always someone available, regardless of the time of day."

UPGRADING AND EXPANDING INTO THE FUTURE

Testifying to the CBC's satisfaction with NetApp HCI, Ludwig has big plans for both the short and long term. "My long-term note is to separate out each environment— be it development, application delivery, or other system—add thousands of VMs to that chunk and connect it to a dedicated HCI."

As a company committed to maintaining a leadership position and ensuring that its customers enjoy the best possible experience,

the CBC can't imagine life without NetApp HCI. "HCI is the top enterprise solution out there," Ludwig says. "It's helping us move forward and redefine our data centers. And it gives me the peace of mind and confidence I need to make sure that our customers continue to be satisfied, and that we continue to be the market's number one beverage provider."

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ONTAP Select 2TB Premium license

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DUCATI | PROBLEM SOLVED

NetApp® HCI gives Ducati the capacity and speed the company needs to rapidly analyze and use massive volumes of real-time data, providing a competitive edge in racing while helping to shape the next era of high-performance street motorcycles.

Ducati Wins with NetApp HCI

In the competitive, fast-paced world of high-end motorcycle manufacturing, rapid innovation is foundational to success. Ducati knew that the data being generated by its bikes around every turn and straightaway—both on the track and on the street—could be captured and used to optimize racing performance while helping to elevate the full, 360-degree experience that the company delivers to its loyal customers worldwide.

30%
reduction in time to market

Processes
300TB
of data

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> "NetApp has showed us the power of its comprehensive suite of solutions, from all-flash storage systems to HCI to all of the opportunities offered by NetApp cloud data services. The company has helped us capitalize on today's business opportunities while we innovate for tomorrow."

Konstantin Kosternarov
Chief Technology Officer, Ducati Motor Holding

Ducati equipped each of its MotoGP motorcycles with more than 60 physical sensors, generating a tremendous amount of real-time data. In an environment where a few thousandths of a second can mean the difference between winning and coming in a close second, Ducati needed an infrastructure capable of capturing, storing, and very quickly transforming massive amounts of data into actionable insights that the company can use to fine tune its high-performance machines. This infrastructure also needs to be capable of easily scaling with demand and to offer rock-solid stable performance. NetApp® HCI was the obvious choice.

DATA DRIVES INNOVATION. INNOVATION DRIVES PERFORMANCE.
Ducati needed the ability to rapidly analyze the data collected from its racing bikes and apply the resulting insights to optimizing performance. NetApp HCI enabled the company's engineers to conduct telemetry processing directly inside the box—on the track and in real time. This means that Ducati can analyze data faster than ever before, resulting in more insights in less time, which greatly increases the chances for victory both on and off the track.

"A powerful infrastructure like NetApp HCI allowed us to count on compute and storage performances that saved us time in the development cycle," says Stefano Rendina, IT manager, Ducati Corse. "We now have a more powerful local data center, 6 times the storage capacity, 4 times the compute power, higher storage throughput, and especially a 'real compute' unit to perform our analysis that we did not have in the past."

When Ducati couples this data with algorithms executed in NetApp HCI, the company realizes improved bike settings that can be applied in the next race.

"We also used NetApp Professional Services to create scripts that accelerate the operations as we arrive at a new circuit or when we leave after the race," Rendina says.

ACCELERATING THE ECONOMICS OF TRANSFORMATION
With "connected bikes" and NetApp HCI, Ducati can rapidly gather and process real-time data from bikes around the world, generating insights that engineers can use to optimize performance, safety, and rideability for generations of riders to come. And by moving its data to the hybrid cloud and leveraging NetApp's high-performance computing, Ducati has reduced by 30% the time required to develop prototypes and get new motorcycles to market, while the cost of powering and cooling the company's data center has dropped by 70%.

FROM THE RACETRACK TO THE STREET AND BEYOND
Ducati has now rolled out its "connected bikes" to the streets. The company is collecting data from more than 15,000 motorcycles around the world, with plans to extend that capability to 150,000 bikes by 2020. Ducati monitors a variety of factors—including road conditions, weather,

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environmental temperatures, and driving modes—to gain valuable insights into how these variables impact bike performance. This information helps the company create increasingly intelligent bikes that offer improved performance for riders, while giving Ducati even more detailed data. The data is used as a catalyst for innovation across all lines of business to create the exceptional experience that customers demand.

"The data is leading us in new directions that will take the company to new areas. NetApp knows our business better than we could ever imagine," says Konstantin Kosternarov, chief technology officer, Ducati Motor Holding. "NetApp has been with us every step of the way and always has our back. NetApp is one of the few companies we know that can help virtually every part of our business."

HCI DELIVERS ADVANCES IN DATA MANAGEMENT

NetApp HCI has enabled Ducati to leverage enterprise-class features of NetApp ONTAP®, which has helped improve the sophistication of the iconic manufacturer's data management strategy, including versioning, security, and NetApp Snapshot™ copies. The company has also gained the ability to integrate NetApp HCI with Active Directory to simplify and automate the management of data access. Because of its winning track record with NetApp, Ducati plans to create a disaster recovery and business continuity plan for the first time in the company's history. Ducati's Italian-born passion for performance and NetApp data-driven technology are proving to be a winning combination.

"NetApp has showed us the power of its comprehensive suite of solutions, from all-flash storage systems to HCI to all of the opportunities offered by NetApp cloud data services. The company has helped us capitalize on today's business opportunities while we innovate for tomorrow," says Kosternarov

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All-flash FAS

High-performance computing

Hybrid cloud

Machine learning and artificial intelligence

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Children's Mercy
KANSAS CITY

CHILDREN'S MERCY | PROBLEM SOLVED

To deliver high-quality, compassionate pediatric care in the Midwest, and around the world, Children's Mercy Hospital in Kansas City depends on NetApp® technology to make a life-saving difference.

Children's Mercy Hospital Turns Digital Leader and Delivers World-Class Care with NetApp

U.S. News and World Report recently ranked Children's Mercy Hospital in Kansas City as one of the best children's hospitals in the United States. David Chou, the hospital's VP, CIO, and CDO, says that using the latest technology is one of the key reasons for that distinction.

More than
500K
children treated annually

8,000
caregivers access information

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"NetApp HCI allows me the flexibility to scale. It allows me to increase performance, increase storage, based on my needs on demand. It allows me to adjust my technology solution based on the constantly changing needs of hospitals like ours."

David Chou
VP, CIO, and CDO, Children's Mercy Hospital

Each year more than half a million children seek treatment at Children's Mercy Hospital in Kansas City. In 10 specialties, from pediatric cancer treatment to pediatric neurosurgery, all children receive world-class care, regardless of their family's ability to pay.

Chou knows that the right technology can improve care and reduce costs. His vision included turning Children's Mercy Hospital into a healthcare digital leader. He found exactly what he was looking for in NetApp HCI and the NetApp Data Fabric, which is NetApp's strategy for simplifying and integrating the orchestration of data across hybrid multicloud environments.

"We wanted a platform that would make us future-proof and allow us to easily move workloads between the cloud and storage on the premises. That's exactly what we got with NetApp HCI and the Data Fabric," Chou said. "We can easily scale to meet both our business and technological needs."

SIMPLICITY EQUALS PATIENT SUCCESS

While most of Chou's efforts are directed at improving patient care, he also wants to use technology to handle such everyday tasks as scheduling conference rooms to make it easier for the hospital staff to make presentations and evaluate data.

Because hospitals like Children's Mercy must deal with multiple products to handle nonmedical tasks, they need a system that can integrate those tasks seamlessly into their existing IT infrastructure.

"Have you ever noticed that with consumer products, you can have Google Chromecast and Apple Music working together in your house?" Chou asks. "With NetApp HCI, I have the foundation to pull everything together so it's just that easy in our hospital workspace."

FUTURE-PROOF IT INFRASTRUCTURE

Because hospitals handle and store ever-increasing amounts of data, one

SOLUTION COMPONENTS

- The initial deployment is for a 4,000-seat Horizon View EUC environment.

- There are 14 HCI chassis across 2 racks with 42 compute and 14 storage nodes.

- The environment is being rolled out as pods.

- Each pod is made up of 19 compute and 5 storage nodes to support approximately 2,000 desktops.

- NetApp held back (in a separate NDE run) a 4x4 configuration for a test/sandbox environment.

- These test nodes will be rolled into the production pods at a later time.

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of the many reasons Chou selected NetApp HCI is that it can easily scale at a moment's notice. NetApp HCI combined with Data Fabric also makes it easy to switch workloads from on premises to the cloud without purchasing any additional software or hardware.

"NetApp HCI allows me the flexibility to scale. It allows me to increase performance, increase storage, based on my needs on demand. It allows me to adjust my technology solution based on the constantly changing needs of hospitals like ours."

BETTER CARE WITH VIRTUAL DESKTOPS

With more than 8,000 caregivers, Children's Mercy Hospital needed to make sure that everyone associated with patient care can access the same information at the same time from anywhere on campus using a virtual desktop.

The information looks the same on a desktop computer as it does on a virtual desktop, so caregivers don't have to spend precious time searching for information about a patient's condition or medications. Caregivers tell Chou that saving as little as 30 seconds can make a major difference when facing the concerns of worried families.

As soon as the virtual desktops become the standard at Children's Mercy Hospital, Chou plans to expand the functionality to mobile devices. "Some patients want to speak with their doctors virtually over their

smartphones," he says. "In the future, this kind of experience will be routine."

Chou's vision for the future of the hospital also includes a continued reliance on NetApp solutions. "I'm always looking 3 to 5 years ahead to make sure the systems we have today will be adaptable to our future business needs," Chou says. "In NetApp we have a company that is both a trusted business and technology partner. We know they will be there when they need them."

SOLUTION COMPONENTS

NETAPP PRODUCTS

NetApp HCI Compute Nodes

NetApp Storage Nodes

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HomeAdvisor

HOMEADVISOR | OPPORTUNITY

NetApp helped HomeAdvisor better manage its data across a complex operating environment while boosting performance and improving cloud integration.

Data Consistency and Performance Critical for HomeAdvisor

NETAPP HELPS HOMEADVISOR IMPROVE DATA QUALITY, PERFORMANCE, AND CLOUD INTEGRATION

Like many successful companies, HomeAdvisor has to constantly manage its growth. In 2017, it merged with Angie's List and has grown tremendously, helping millions of homeowners tackle projects. This requires a robust, reliable infrastructure to handle HomeAdvior's complex data and hybrid multicloud environment. In 2018, HomeAdvisor made a significant enterprise decision to use a NetApp" infrastructure, including AFF, FAS, NetApp SolidFire", and NetApp HCI.

250
HomeAdvisor developers rely on NetApp HCI for better access, resources

0
downtime with NetApp AFF systems

Fast
continuous service for Oracle

✉ **NETAPP.COM/CONTACT**

n NetApp®

When you think about the challenges that HomeAdvisor faces in trying to provide local services, it helps to know that as of January 2020, there were about 42,000 zip codes in the United States. These local areas need very local services.

Each of these zip codes has thousands of service professionals ready to remodel kitchens or replace windows. But they need the right match: homeowner to service provider.

That's the primary business challenge for HomeAdvisor. The underlying technology challenge is in some ways even more daunting. How do you deliver ever-changing, hyper-local data to consumers with split-second accuracy and consistency? How do you match the right problem to the right solution with very limited input data?

Essentially, you need a flexible, powerful, data-driven infrastructure. And that's why HomeAdvisor chose NetApp. HomeAdvisor wanted to enhance its large Oracle database and CRM solution by bolstering its overall data management approach. Specifically, HomeAdvisor wanted to increase its capacity to grow and improve performance, while at the same time streamlining reporting and reducing TCO.

HOW IT WORKS: DATA IS FRONT AND CENTER

Colin Mariner, vice president of data center operations for HomeAdvisor, said that the company's major asset is its data and business model.

"HomeAdvisor is unique in the fact that we have customers on both sides of the transaction," Mariner said. "We have customers on the service provider side of the transaction as well as the homeowner, so we really serve a need for both sides of that transaction."

For it to work successfully, HomeAdvisor must have a reliable system that can easily scale and adjust to the dynamics of the marketplace. Mariner said the process starts with data.

"Data plays a big role in how we provide services to our customers, as well as support our contractors through the process," Mariner said. "We use data for everything—from information about customers' homes to every detail about the job. We keep track of reviews for our service providers and how well those jobs are doing. And we constantly will speak with customers to make sure that we're providing the best service."

Data collection and tracking is just one piece of the puzzle, and a fairly straightforward technical challenge. A bigger problem is how to add value to that data, Mariner said. For example, when consumers click a button online they expect a timely action, such as a status on a project or to make a request.

"We're trying to bridge that gap as much as possible with that data," Mariner said. "There are several different workloads that we have to transfer between cloud services, business intelligence services, internal CRM systems, and local call centers. The way that we bridge that gap is by consistent data across those workloads."

In the background, HomeAdvisor has dozens of teams with specialized functions that need fast, accurate access to the data.

"We have many different consumers of data within the organization," Mariner said. "They depend on that data being correct. We use data for business intelligence and our internal CRM system. We have over 250 developers working constantly with data for new services and new products that are designed to speed and ease the consumer experience within our platform."

NetApp®

> ## "Our data fabric running on a NetApp ecosystem allows us to do all of the things that we want to do as a business."
>
> Colin Mariner
> VP of Data Center Operations for HomeAdvisor

And for a company that truly embodies the "think globally, act locally" slogan, data has to be relevant.

"The biggest challenge working with our stakeholders is they want data now, they want it to be consistent, and they want it yesterday," Mariner said. "With a data fabric that we've put in place with the help of NetApp, it's really helped us to deliver that data, and keep all of our data consistent across multiple locations."

THE BENEFITS: BETTER PERFORMANCE, MORE INNOVATION

Mariner said HomeAdvisor went through a complete storage upgrade. As part of the evaluation process, the company wanted to satisfy several needs such as increased performance, data protection, and leading cloud integration.

"We brought NetApp in to solidify our architecture. Now, from a data perspective and a physical storage perspective, we have nothing to worry about—short term and long term," he said. "The stability within NetApp is allowing us to focus the business on how we expand into the cloud. It is the reason why we went with NetApp. And it was a very large deciding factor when replacing all of our storage over the past year."

As a bonus, Mariner said that moving to NetApp products has improved productivity because of its simplicity. "We moved our entire backup strategy over to NetApp because of ease of use," he said. There is a proven increase in efficiency and a built-in confidence that the solution will just work—no more downtime, no more worries about data loss.

"At HomeAdvisor, we utilize NetApp AFF systems for our Oracle database workloads," Mariner said. "We use that to keep it consistent across multiple data centers, to scale horizontally across different regions, and we use SnapMirror in order to keep a consistent backup."

Mariner said the all-flash system has been a key differentiator.

"The AFF system is top of the line, best of breed for us," he said. "AFF from our perspective is the only way to go for our production database. The AFF systems are exactly as advertised. We've been able to upgrade very smoothly with zero downtime. And we've been able to increase performance significantly."

And with the addition of NetApp HCI, HomeAdvisor now has a scalable, on-premises hybrid cloud infrastructure that can help transform its cloud ambitions and development efforts.

"Our developers release code daily and we need to make sure that we're providing the most consistent environment for them to do so," Mariner said. "We need to progress things in a much quicker way. NetApp HCI has allowed us to do that."

There is also huge value in the configurability of the NetApp storage systems, Mariner said.

"NetApp has done a really good job of allowing us to build in automation and CI/CD pipeline above the storage layer, meaning once the storage layer is set up, everything is configurable through API."

Whether it's optimizing data across workloads, having the confidence of zero downtime, or building the best type of cloud environment, HomeAdvisor is now able to focus on its customers and not on unnecessary technical issues.

n NetApp®

"There's a huge sense of comfort and trust that HomeAdvisor has in NetApp, and that's been earned over time," Mariner said. "The NetApp platform is so solid and the people are so knowledgeable.

"At HomeAdvisor, we believe that a hybrid multicloud is really the path forward for our growth. Our data fabric running on a NetApp ecosystem allows us to do all of the things that we want to do as a business."

SOLUTION COMPONENTS

NetApp SolidFire H610S-1

SolidFire License Renewal

NetApp HCI Starter Kit

NetApp FAS2720 12x 10TB NL-SAS

NetApp AFF A300 Small
- AFF A300 Mini
- NetApp Cloud Volumes ONTAP®
- Storage Efficiency Guarantee

PARTNER

Trace3: www.trace3.com/

LEARN MORE

www.netapp.com/us/products/storage-systems/all-flash-array/aff-a-series.aspx

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NetApp is the data authority for hybrid cloud. We provide a full range of hybrid cloud data services that simplify management of applications and data across cloud and on-premises environments to accelerate digital transformation. Together with our partners, we empower global organizations to unleash the full potential of their data to expand customer touchpoints, foster greater innovation and optimize their operations. For more information, visit www.netapp.com. #DataDriven

NetApp NAS

NetApp NAS Leadership – Gartner Magic Quadrant

Figure 1. Magic Quadrant for Primary Storage

Source: Gartner (September 2019)

***NetApp** recognized as a **Leader** in 2019 Gartner Magic Quadrant for Primary Storage*

This Magic Quadrant was published as part of a larger research note and should be evaluated in the context of the entire report. The full report is available from NetApp here.

Gartner.

NetApp

NetApp NAS Leadership - Object Storage

Product or Service Scores for Hybrid Cloud Storage

Vendor	Score
NetApp StorageGRID	4.20
Western Digital ActiveScale	4.13
Cloudian HyperStore	4.12
Hitachi Vantara HCP	4.10
SwiftStack Storage	4.08
Huawei FusionStorage	3.84
Caringo Swarm	3.83
DDN WOS	3.31
Dell EMC ECS	N/A
IBM COS	N/A
Red Hat Ceph	N/A
SUSE Enterprise Storage	N/A
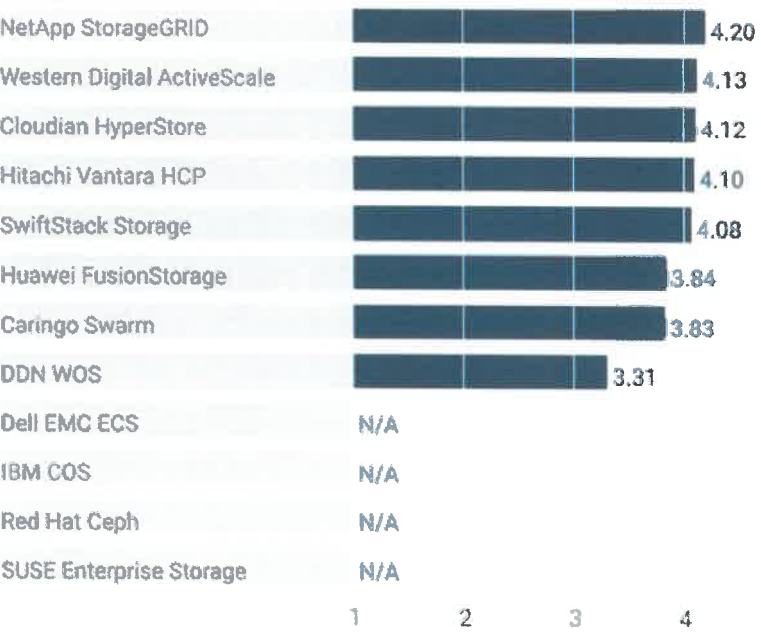
As of 22 January 2019

© Gartner, Inc

Gartner.

NetApp StorageGRID receives highest Product or Service Score for **Hybrid Cloud Storage** in Gartner Critical Capabilities for Object Storage report.

Gartner Use Case	NetApp StorageGRID score (out of 5)
Analytics	4.20
Archiving	4.19
Backup	4.18
Cloud Storage	4.19
Hybrid Cloud Storage	4.20

Customers & prospects can download a complimentary copy of the Gartner report here.

NetApp

NetApp NAS Leadership - IDC MarketScape

Worldwide Scale-out File-Based Storage 2019 Vendor Assessment

IDC MarketScape Worldwide Scale-Out File-Based Storage

Strategies

Source: IDC, 2019

IDC MarketScape: Worldwide Scale-out File-Based Storage 2019 Vendor
Assessment, Doc # US45355019, December 2019
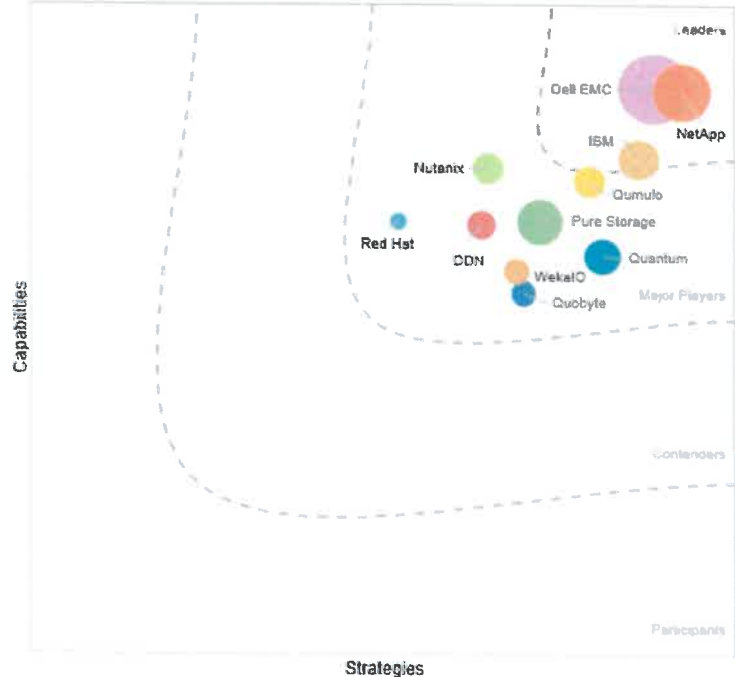
IDC MarketScape report excerpt:

NetApp Strengths

NetApp's FBS offering is a very well-established offering in the market with worldwide adoption across several workloads and use cases. NetApp has an extensive and loyal customer base that is well skilled in the use of ONTAP and may lead to adoption of ONTAP in the public cloud.

Consider NetApp When

Customers in need of an FBS on-premises and hybrid cloud strategy should consider NetApp because of its expanded product portfolio, investment, and vision.

The report is available from NetApp here.

NetApp

NetApp NAS Leadership

ONTAP® is the World's #1 Open Networked Branded NAS Storage OS

Ranked #1 in Capacity Shipped
Top 5 Branded Storage OS Worldwide Open Networked
Capacity Market Share
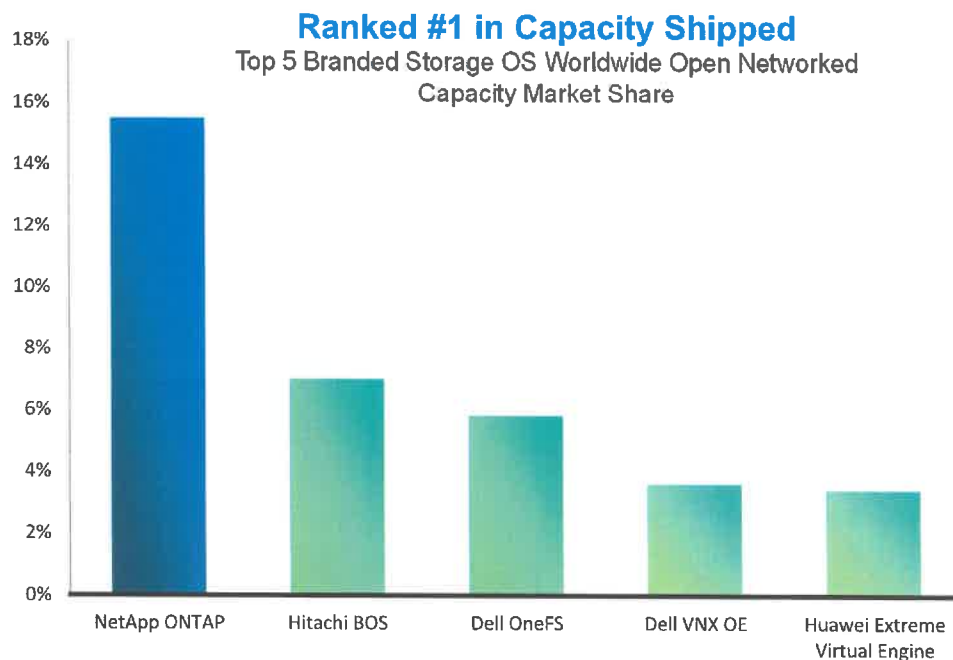
The latest IDC Enterprise Storage Systems Tracker confirms that
NetApp ONTAP® was **ranked #1** based on sales of Open Networked Enterprise Storage Systems (for both revenue and terabytes).

n NetApp

# OnTap OS - All Flash FAS Enterprise-Grade Capabilities

In-line Deduplication

In-Line Compression

In-line Zero Deduplication

Data Compaction

SnapMirror to Disk, Tape, ONTAP Cloud & Select

SnapManager Application Consistent Snapshots

iSCSI FCoE FC **ONTAP 9** NFS CIFS Encryption

Secure Multi-Tenancy

Snapshots, FlexClones & Quotas

Scale Out by Adding Controllers
(Maximum 24 Controllers)

Scale up Individual Controllers

HA PAIR   HA PAIR   HA PAIR   HA PAIR

All Flash FAS

HDD FAS

FlexVols

All Flash FAS

Data Compaction

Hybrid FAS

Quality of Service

SnapVault to Disk, Tape, ONTAP Cloud & Select

>4 million IOPS and multi PB's of all-flash capacity

- NetApp® All Flash FAS: scalable high performance for dedicated workloads
- Mixed all-flash and hybrid FAS: one storage repository for all workloads

6

NetApp

Fabric Pool - Automatic Cloud Tiering of Cold Data to Object Store/S3

## FabricPool: Keep only hot data on your flash system
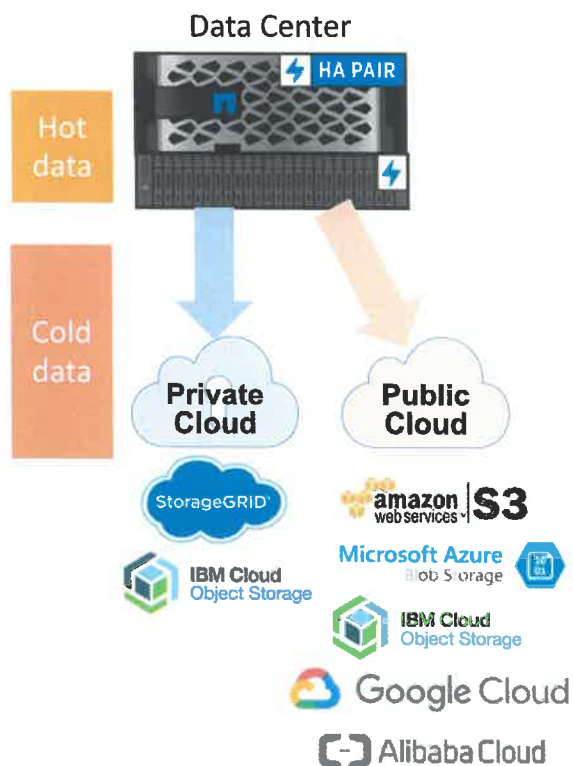
- Reduce primary flash storage needs by >50%
  - Decrease the size of new system configurations
  - Reclaim capacity and consolidate more workloads on existing systems
- Simple setup and automated management
- More options for primary system
  - AFF systems, FAS systems (all-SSD aggregates), ONTAP Select, Cloud Volumes ONTAP
- Many tiering options
  - Cloud: Amazon, Microsoft, Google, IBM, Alibaba
  - On-Premises: NetApp StorageGRID, IBM (Cleversafe)

NetApp

FlexGroup Volumes

- Nondisruptive scale-up and scale-out

- Designed for large quantities of files

- Efficient Metadata handling

- Easy to deploy and manage

- High performance

- Massive capacity
  - **Capacity in the petabytes**
 - **Hundreds of billions of files**

Do more with less.
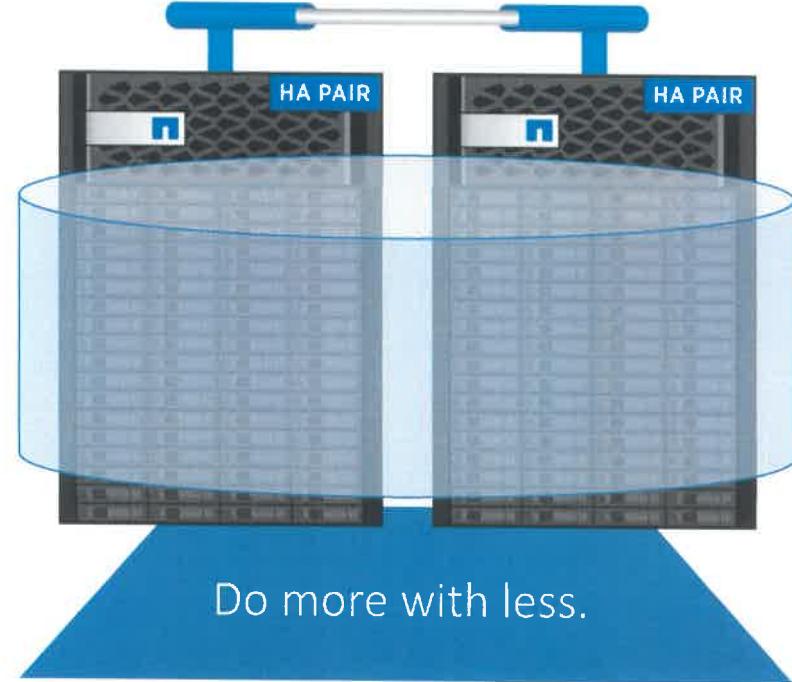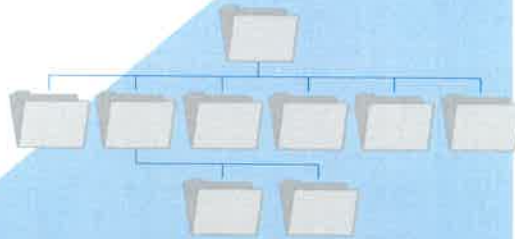
NetApp

NetApp Data Protection Features

These features are included with no additional charge and can potentially replace or compliment NetBackup and/or VEEAM

- SnapShot – Instantaneous local point in time backups
  - Instant Restores
  - Protects from local to data center issues – Malware attacks, file deletion, data corruption

- SnapMirror – Site to site replication
  - Asynchronous, Semi-Synchronous and up to SnapMirror Synchronous
  - Protects from primary site failure to have data availability on secondary site

- SnapVault – Backup
  - Useful for restoring files from 1-week, 1-month, years ago etc.
  - Analogous to tape

- Snaplock – Legal Hold backup
  - Cannot be deleted without destroying the equipment

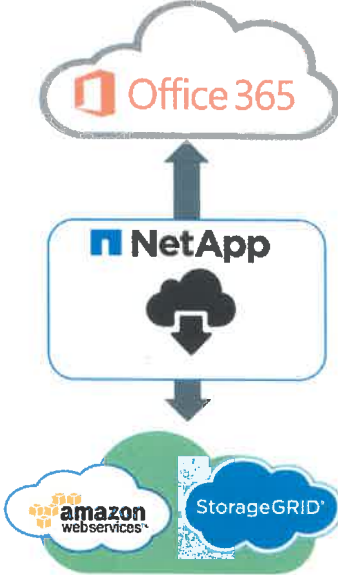**n NetApp**

NetApp Data Protection Portfolio

NetApp-to-NetApp

ONTAP®
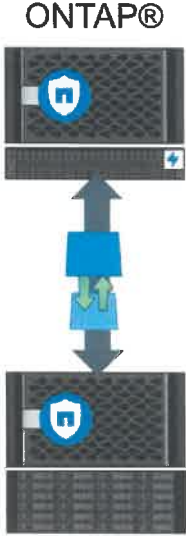
Any-to-Cloud
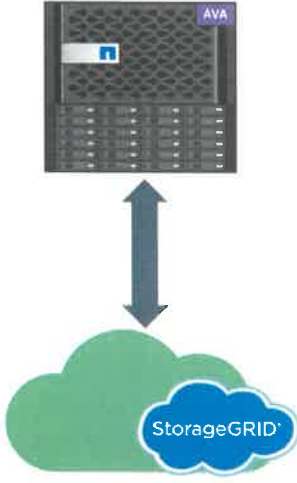
Protect-from-Cloud

Any-to-NetApp

E-Series

NetApp NAS Value Proposition

NetApp

Value Proposition of NetApp NAS Solutions

- #1 NAS OS in the World

- #1 Gartner Magic Quadrant for GP Storage

- No performance loss tiering and no extra license required

- No performance loss deduplication and inline compression and no extra license required

- Block Level deduplication and compression treats all files equally regardless of size or protocol

- No recynch period when new storage is added

- Single namespaces up to 25PB

- Six 9's of availability

- Cloud Ready

- End user file restore self service (Previous Versions list)

- File Auditing

- Built in backup and Archive iincluded

- Efficient Metadata Handling even with small files and large numbers of files

- Extreme Performance #1 SPECfs Benchmark

- Adaptive QoS Included: Automatically adapt resources and protect critical applications as workloads change

- Tiers to and integrates with on premise or cloud S3 Including AWS, Azure and Google As well as NetApp StorageGRID

- Built in Encryption included

- Active Directory Integration

- Additional protocols included CIFs, NFS, pNFS, iSCSI, FC, FCoE, NVMe

- All features work equally for all protocols

- Mix and match controllers, only two controller minimum base purchase for redundancy

- Application aware snapshot, replication, backup and Archive

- Secure Multitenancy included

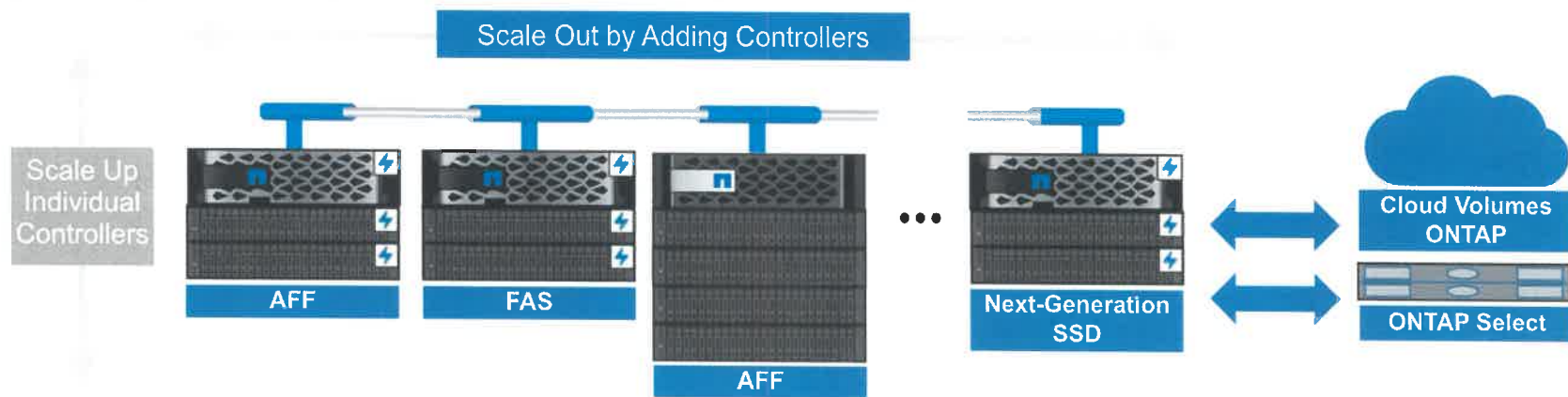- Ethernet Cluster interconnect = No expensive proprietary InfiniBand interconnect

■ NetApp

Future Options

n NetApp

Respond to Changing Needs

Scale-up or scale-out capacity and performance – no disruption, no silos

- Scale seamlessly by intermixing your choice of flash and hybrid nodes.
- Upgrade hardware and software or scale up without disrupting users.
- Incorporate software-defined, cloud, and future-generation flash.

NetApp

NetApp co-develops and partners with the world's biggest public cloud providers

Azure NetApp Files

Cloud Volumes ONTAP

Cloud Volumes Service for Google Cloud

Cloud Volumes ONTAP

Cloud Volumes Service for AWS

Cloud Volumes ONTAP

SAP | Opensource Apps | Enterprise Apps | Windows File Services | HPC and Genomics

■ NetApp

Disaggregated Hyper Converged Infrastructure

NetApp® HCI is an enterprise-scale, hyper converged infrastructure for hybrid clouds that gives you a public cloud experience from your private cloud. Deliver an as-a-service experience to your users while maintaining complete control over performance, availability, and costs.

Faced with rapidly evolving business needs and unbridled data growth, today's enterprises must maintain a proactive, agile environment to be competitive and grow business. Public cloud providers are appealing because they make it easy for business to quickly spin up new services and make them immediately and globally available in today's digital sphere. Although this approach may address immediate needs, it can result in loss of control from financial, regulatory, and management standpoints.

To contain costs and regain control of company data, IT departments must deliver applications and workloads with the same simplicity, efficiency, and flexibility offered by major public cloud providers. However, traditional data centers are straining under web applications, mobile users, and an influx of data that they were not designed to handle. The complexity of traditional data centers makes it more difficult for IT to launch new, agile applications quickly enough to meet developer demand and the business value they provide.

Today IT is faced with disparate environments between public clouds and private clouds. They have to contend with legacy applications on-prem, cloud native app development, and support the expectations of public clouds including easy to consume and fast to deploy user experiences.

Command Your Cloud—with Disaggregated Hyperconverged Infrastructure for Hybrid Clouds

NetApp® HCI is an enterprise-scale, disaggregated hyper converged infrastructure designed for hybrid, multiclouds that consists of software-defined compute, network, and storage. It delivers a public cloud consumption experience with simplicity, dynamic scale, and operational efficiency. With NetApp HCI, WV Lottery's infrastructure and cloud architects can seamlessly access services from their on-premises or from any third-party cloud provider and mix and match these services to optimize resources for specific workloads and applications.

NetApp HCI gives you the ability to consolidate and easily manage multiple applications with guaranteed workload performance that your users and customers demand. Scale compute and storage resources independently so you can grow on your terms and never pay for more than you need. Deploy in minutes with a turnkey cloud infrastructure that eliminates the complex management of traditional three-tier architectures.

"For virtually every application that we have moved to the new system, our users have noted a performance improvement. Some things are definitely running twice as fast. Also, we did pay a sizeable set of maintenance fees on the old array—so basically, we're getting new performance for what we were paying to keep the status quo."

— Sean Henry Senior Manager, American Showa

In addition, NetApp HCI is integrated into your data fabric. You can use the full potential of your applications, with their associated data and the services they require, across any cloud. With the

NetApp HCI future-proof environment you can seamlessly add multiple new workloads such as Splunk, SAP, VDI, SQL Server, MongoDB, and more, to support your business transformation.
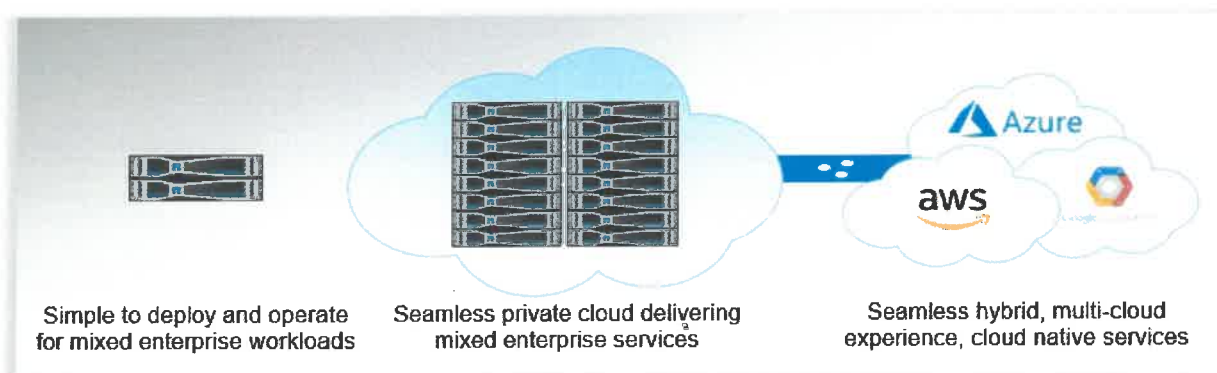
Figure 1: **NetApp HCI: A seamless hybrid multicloud experience** – *From hyperconverged infrastructure to hybrid-cloud infrastructure.*

With NetApp HCI WV Lottery can:

- Scale on your terms
- Simplify and automate
- Achieve a competitive advantage

Scale on Your Terms

NetApp HCI delivers a hybrid cloud infrastructure that addresses enterprise-class multicloud agility, scale, and services. It brings together NetApp Element® software with all-flash storage core processing for system-critical applications; graphical processing units for virtualized desktops; and networking. All parts of the infrastructure are fully architected and managed as an appliance, enabling unique efficiencies.

Increase productivity with guaranteed, predictable performance across all your applications with the SolidFire® Element software's innovative three-dimensional Quality of Service (QoS). Future-proof your investment with an agile, scale-out architecture that lets you independently scale compute and storage resources on demand, without disruption from generation to generation.

Simplify and Automate to Empower Your Business

Running a modern enterprise means being constantly disrupted by unpredictable competitive challenges. Traditional approaches to leveraging technology are too slow in delivering innovation at the pace at which business ecosystems are changing. To quickly adapt to these changing business needs, enterprise IT departments must become agile. Through embracing new DevOps tools, IT developers become more effective in implementing innovative solutions, reducing time to value for new mission-critical business applications.

NetApp HCI for Google Cloud's Anthos

Anthos is a hybrid cloud Kubernetes data center solution. Run Anthos on NetApp HCI and get an easy-to-manage, enterprise-scale foundation for DevOps and PaaS. Build and manage your virtualized and containerized workloads on a single platform and Optimize data performance while effectively controlling your data in any environment.

NetApp HCI and Red Hat OpenShift Container Platform

The Red Hat OpenShift Container Platform on NetApp HCI simplifies application delivery and accelerates your business by enabling you to outpace your competition and quickly deliver differentiated value by speeding the building, deployment, and management of new services. Increase your business's velocity through a data-driven development model that can help you deliver innovative applications to market more rapidly and iteratively. Reduce variable performance by providing granular control of every application, on demand, enabling more positive customer experiences.

Achieve a Competitive Advantage

The more you can automate routine tasks, the more you can eliminate the risk of user error associated with manual operations, while also freeing resources to focus on higher value assignments that drive business.

NetApp HCI streamlines installation through an intuitive deployment engine that has automated over 400 inputs to fewer than 30 to get you up and running in about 45 minutes. Simple centralized management through VMware gives you control of NetApp HCI through tools you already use, so you can focus valuable resources on higher priorities that drive business growth. A robust suite of API's enables seamless integration into higher-level management, orchestration, backup, and disaster-recovery tools.
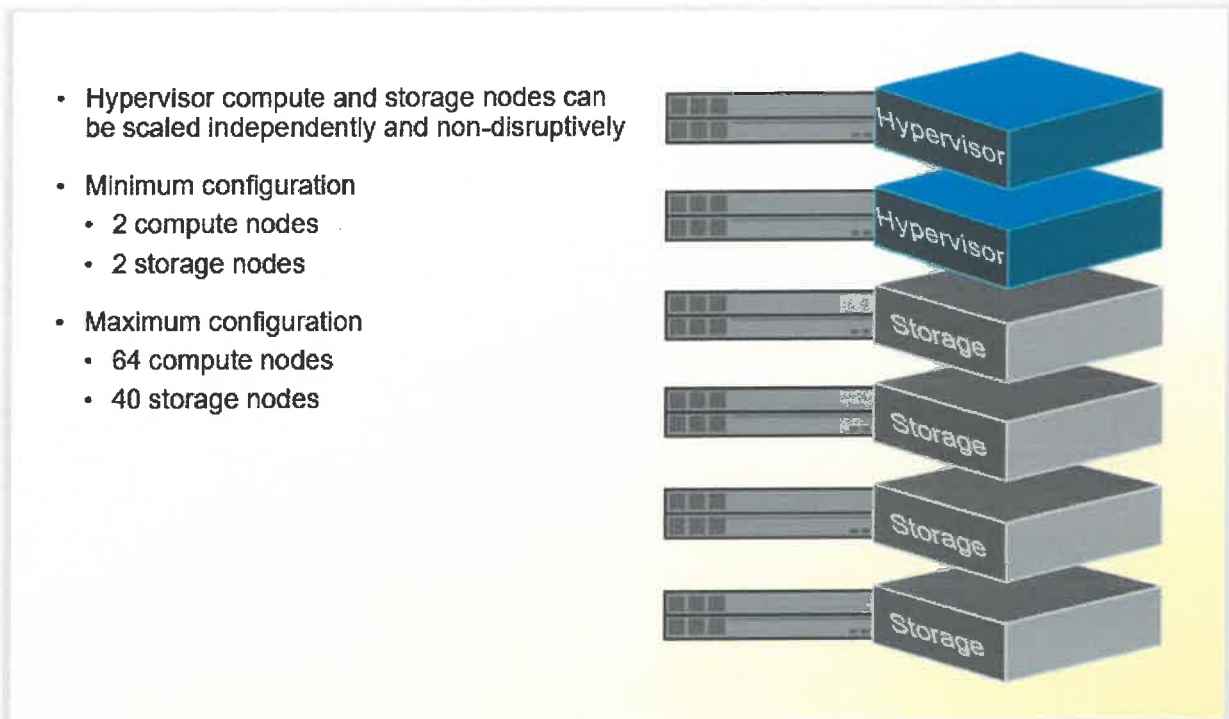
Enterprise-Scale Infrastructure

NetApp HCI delivers IT simplicity and business efficiency, security, and flexibility. NetApp HCI is deployed and maintained as a single appliance with compute and storage nodes that can scale independently. Independent node architecture gives you the ability to intermix product generations to unlock new capabilities without forklift upgrades. Once you meet the minimum configuration requirements, you can mix and match storage and compute nodes and sizes that integrate seamlessly to scale your environment non-disruptively.

> *"NetApp HCI allows me the flexibility to scale. It allows me to increase performance, increase storage, based on my needs on demand. It allows me to adjust my technology solution based on the constantly changing needs of hospitals like ours."*
>
> *— David Chou VP, CIO and CDO, Children's Mercy Hospital*

- Hypervisor compute and storage nodes can be scaled independently and non-disruptively

- Minimum configuration
  - 2 compute nodes
  - 2 storage nodes

- Maximum configuration
  - 64 compute nodes
  - 40 storage nodes

Figure 2: Enterprise scale minimum HCI configuration – *Once you meet the minimum configuration requirements, you can mix and match storage and compute nodes and sizes.*

Get guaranteed storage efficiency with global, always-on duplication and compression across all workloads. NetApp HCI is backed by world-class support, with a single point of contact for both hardware and software. Support includes 24/7/365 worldwide availability, with 4-hour on-site response for critical system issues.

Element Capacity Licensing

Capacity licensing is a pricing model that gives you the ability to purchase data storage based on how much capacity is provisioned on your storage infrastructure. It decouples purchasing Element software from the underlying NetApp HCI.

Capacity licensing gives you economic benefits across an entire data center footprint to better align with ever-changing needs. Purchase only the software you need today and "pay as you grow". It also passes through hardware at cost, eliminating the need to source, validate, and integrate your hardware. With capacity licensing you can:

- Benefit from licenses that are transferable and not locked to a particular hardware

- Pool capacity across your enterprise to eliminate stranded capacity and enable geographic flexibility

- Scale hardware and software independently; only buy what you need, when you need it

- Use pricing based on provisioned capacity to reduce dependency on data reduction efficiency rates

- Realize the long-term time value of money by delaying the purchase of hardware or software packs until you are ready to utilize each

- Use volume discounts to drive down the cost of software as storage capacity grows, creating a more predictable purchasing model

NetApp HCI Rental Solution

NetApp HCI Rental Solution is a month-to-month, on-premises flexible deployment model. NetApp HCI Rental Solution delivers economical and operational efficiencies with a public cloud experience that is simple, fast, and easy to deploy in your own private cloud. With this Rental Solution you can rapidly innovate, manage, scale, and consume NetApp HCI at the pace of your use with radically simple contract terms and monthly billing. With NetApp HCI Rental Solution you can:

- **Manage regulatory risk**. Maintain jurisdiction over regulatory compliance and data security while bringing the benefits of the public cloud to your on-premises private cloud.

- **Boost economic flexibility**. Remove or reduce the capex burden of your infrastructure and achieve the pay-per-use flexibility of the public cloud.

- **Scale on your own terms**. Lower barriers to entry and scale on your own terms by paying per node, per month, without the exposure of asset ownership.

NetApp HCI Portfolio Specifications

The following table details specifications of the NetApp HCI Storage and Compute nodes.

Table 1: NetApp HCI storage and compute nodes.

NetApp HCI Portfolio Key Specifications			
Compute Nodes	**H410C**	**H610C**[1]	**H615C**
Rack Units	2 RU, half-width	2 RU	1 RU
CPU/GPU	2 Intel Xeon Gold 5122, 4 cores, 3.6GHz	2 Intel Xeon Gold 6130, 16 cores, 2.1GHz	2x Intel Silver 4214, 12 cores, 2.2 GHz
	2 Intel Xeon Silver 4110, 8 cores, 2.1GHz	2 NVIDIA Tesla M10 GPU cards	2x Intel Gold 5222, 4 cores, 3.8 GHz
	2 Intel Xeon Gold 5120, 14 cores, 2.2GHz		2x Intel Gold 6242, 16 core, 2.8 GHz
	2 Intel Xeon Gold 6138, 20 cores, 2.0GHz		2x Intel Gold 6252, 24 core, 2.1GHz
			2x Intel Gold 6240Y SpeedSelect, 18/14/8 cores 2.6/2.8/3.1 GHz plus 3x NVIDIA Tesla T4 GPU cards
Cores for VMs	8-40	32	8-48

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[1] NetApp HCI H610C GPU requires NVIDIA Software License.

NetApp HCI Portfolio Key Specifications

Memory	384GB-1TB	512GB	384GB-1.5TB
Hypervisor		VMware vSphere 6.0, 6.5, and 6.7 RedHat OpenStack/OpenShift	
Base Networking	4x 10/25GbE (SFP 28)2, 2x 1GbE RJ45	2x 10/25GbE (SFP 28)2, 2x 1GbE RJ45	2x 10/25GbE (SFP 28)[2],
Out-of-Band Management (optional)		1x 1GbE RJ45	

Storage Nodes	H410S	H610S
Rack Units	2 RU, half-width	1 RU
SSD	6x Encrypting or nonencrypting	12x Encrypting or nonencrypting
Drive Capacity	480GB, 960GB, 1.92TB	960GB, 1.92TB, 3.84TB
Effective Capacity[3]	5.5TB - 44TB	20TB - 80TB
Performance per Node	50,000 IOPS or 100,000 IOPS	100,000 IOPS
Base Networking	2 x 10/25GbE iSCSI (SFP28) 2 x 1/10GbE Mgmt. (RJ45)	2 x 10/25GbE iSCSI (SFP28) 2 x 1/10GbE Mgmt. (RJ45)
Out-of-Band Management (optional)	1x 1Gb RJ45	1x 1GbE RJ45

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[2] Cables and transceivers not included.

[3] NetApp HCI effective capacity calculation accounts for NetApp Element software, NetApp SolidFire Helix® data protection, system overhead, and global efficiency, including compression, deduplication, and thin provisioning. Element software customers typically achieve an effective capacity range of 5 to 10 times the (usable) capacity, depending on application workloads.

Datasheet

NetApp FAS8200 Hybrid Flash System

Quickly respond to changing storage needs across flash, disk, and cloud with industry-leading data management

Key Benefits

Simplify Your Storage Environment
Run SAN and NAS workloads with unified scale-out storage.

Accelerate Enterprise Applications
Reduce latency and speed operations with up to 50% higher performance than that of previous generation.

Maximize Uptime
Eliminate planned downtime to add, upgrade, or retire storage with no disruptions.

Consolidate Infrastructure
Scale up to 57PB, cluster with AFF all-flash systems, and integrate existing third-party storage arrays.

Optimize for the Hybrid Cloud
Easily implement a service-oriented IT architecture with leading cloud integration.

The Challenge
Enabling the data-driven business
As the role of technology has expanded to cover key business operations as well as back-office functions, IT leaders have had to rethink the way they architect storage. Traditional requirements such as storage uptime, scalability, and cost efficiency are still critical, but so are factors such as flash acceleration, cloud integration, unified support for SAN and NAS, and simplified data mining for competitive advantage.

Many enterprises struggle, held back by structural limitations in legacy storage and data architectures. Traditional storage arrays might deliver on basic needs, but are divided into separate silos or are incapable of meeting advanced service requirements and leveraging the cloud.

The Solution
Accelerate business operations with unified scale-out storage
The demands of a data-driven business require a new approach to storage with an integrated combination of high-performance hardware; leading cloud connectivity; and adaptive, scalable storage software. It needs to support existing workloads as well as adapt and scale quickly to address new applications and evolving IT models.

FAS8200 hybrid storage systems are engineered specifically to address these needs. Powered by NetApp® ONTAP® data management software, the FAS8200 unifies your SAN and NAS storage infrastructure. When FAS8200 systems are clustered with NetApp AFF all-flash arrays and integrated with the cloud, you have the control to easily move your data to where it's needed for your business and place it in the storage environment that delivers the best combination of flash performance, storage capacity, and cost efficiency. With proven agility and data management capabilities, the FAS8200 has the flexibility to keep up with changing business needs while delivering on core IT requirements.

Unlock the power of flash
Flash-accelerated FAS8200 hybrid storage systems deliver up to 50% more performance than our previous generation FAS storage, boosting throughput, lowering latency, and meeting stringent service levels. The base configuration of each HA pair includes 2TB of onboard Flash Cache™ based on NVMe technology, which can be expanded up to 4TB of integrated Flash Cache and up to 72TB of total flash per HA pair when leveraging Flash Pool™ intelligent data caching. Hot data is automatically promoted to flash in real time, so you get the full benefit of flash performance.

■ NetApp®

ONTAP 9
Common Data Management

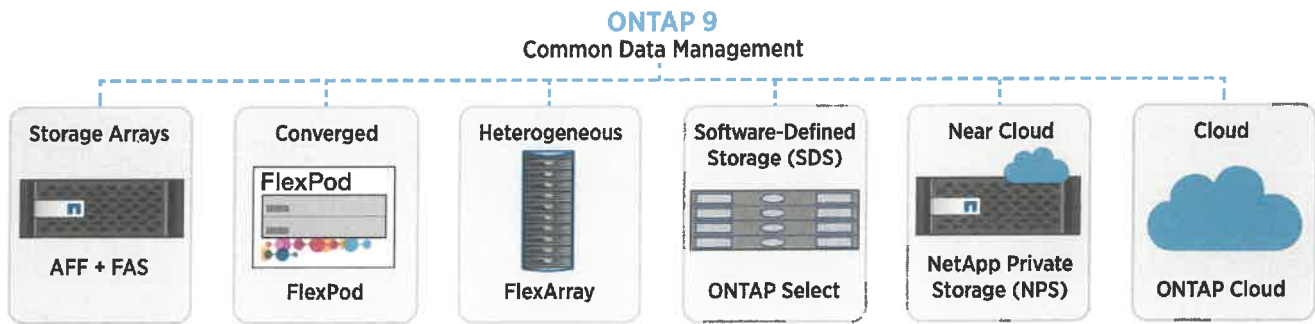| Storage Arrays	Converged	Heterogeneous	Software-Defined Storage (SDS)	Near Cloud	Cloud
AFF + FAS	FlexPod	FlexArray	ONTAP Select	NetApp Private Storage (NPS)	ONTAP Cloud

Figure 1) Standardize data management across architectures with a rich set of enterprise data services.

Scale and adapt to meet changing needs

Optimize and accelerate your storage environment as performance and capacity requirements change. Scale up by adding capacity, adding more flash acceleration, and upgrading controllers. Scale out by growing from 2 nodes up to a 24-node cluster with 57PB of capacity, including combinations of different FAS and AFF models.

FAS8200 systems also support massive NAS containers, which are easy to manage. With the NetApp FlexGroup feature of ONTAP 9, a single namespace can grow to 20PB and 400 billion files while maintaining consistent high performance and resiliency.

With nondisruptive addition and replacement of storage systems and components, scaling occurs without maintenance windows or the challenge of coordinating downtime across teams. Perform your updates during regular work hours.

Achieve unparalleled availability and nondisruptive operations

FAS8200 enterprise storage is engineered to meet demanding availability requirements. All models are designed to deliver 99.9999% availability or greater through a comprehensive approach that combines highly reliable hardware, innovative software, and sophisticated service analytics.

Software and firmware updates, hardware repair and replacement, load balancing, and tech refresh happen without planned downtime. Plus, NetApp Integrated Data Protection technologies protect your data, accelerate recovery, and integrate with leading backup applications for easier management.

Optimize your data infrastructure with the cloud-based predictive analytics and proactive support of NetApp Active IQ®. Prevent problems, save time, and gain insight by leveraging machine learning to get real-time predictions and recommendations based on community wisdom from NetApp's massive user base.

NetApp MetroCluster™ expands data protection to eliminate risk of data loss by synchronously mirroring data between locations for continuous availability of information. A MetroCluster storage array can exist in a single data center or in two different data centers that are located across a campus, across a metropolitan area, or in different cities. No matter what happens, your data can be protected from loss and is continuously available to meet the most business-critical needs. Plus, MetroCluster solutions

based on the FAS8200 offer enhanced configuration flexibility from the new controller architecture, which moves Flash Cache intelligent data caching from the PCIe slots to the motherboard and adds FCVI connectivity to the onboard UTA2 ports.

Get more from existing storage array investments

Simplify your IT operations and deliver more value from existing third-party arrays by using them as additional storage capacity behind FAS8200 systems. FlexArray® virtualization software running on the FAS8200 extends ONTAP to include storage capacity from EMC, Hitachi, HPE, IBM, and NetApp E-Series arrays. Consolidate management of your existing storage to increase efficiency, add support for SAN and NAS workloads, and provide superior data management functionality.

Optimize hybrid cloud deployment

Organizations today are focusing on service-oriented IT architectures where cloud IT models are leveraged to enhance return on investment and assets. The FAS8200 running ONTAP is optimized for private and hybrid cloud with secure multitenancy, adaptive quality of service (QoS), nondisruptive operations, and easily defined tiers of service.

Easily burst analytics and DevOps workloads to the cloud by connecting your FAS8200 to NetApp Cloud Volumes, the first enterprise-class native file service available in major hyperscalers.

For advanced data services that are common between your on-premises and cloud environments, leverage ONTAP Cloud, a version of ONTAP software that runs in Amazon Web Services (AWS) and Azure. Providing the storage efficiency, availability, and scalability of ONTAP, it allows easy movement of data between your on-premises FAS8200 and AWS or Azure environment with NetApp SnapMirror® data replication software.

For organizations that need an enterprise-class hybrid cloud with data governance and security, the FAS8200 can be used in a NetApp Private Storage (NPS) for Cloud solution. With NPS for Cloud, you can directly connect to multiple clouds using a private, high-bandwidth, low-latency connection. Connect to industry-leading clouds such as AWS, Microsoft Azure, or IBM Cloud and switch between them at any time, all while maintaining complete control of your data on your dedicated, private FAS8200.

Build the right long-term platform

When it comes to long-term storage infrastructure investments, it is critical to focus on flexibility for adapting to future requirements, simplification of your storage environment, and total cost of ownership. The FAS8200 provides a significant price-performance benefit. Plus it delivers industry-leading storage efficiency technologies such as inline deduplication, inline compression, inline compaction, thin provisioning, and space-efficient Snapshot™ copies to reduce your cost per effective gigabyte of storage.

It is also critical to look at the security of your data environment. With the NetApp Volume Encryption feature of ONTAP, you can easily and efficiently protect your at-rest data by encrypting any volume on FAS (and AFF) systems. No special encrypting disks required. Plus, optional external key management can further increase security.

In a data-driven business, you also need the ability to leverage data for competitive advantage and to assign resources dynamically for more effective operations. The NetApp OnCommand® suite of management and optimization software is composed of a range of products for use with the FAS8200, including automation, integration, device-level management, and enterprise storage resource management.

Get It Right from the Start Using NetApp Expertise

Whether you're planning your next-generation data center, need specialized know-how for a hybrid cloud environment, or want to optimize the operational efficiency of your existing infrastructure, we have the expertise. NetApp Services and our certified partners can help you navigate your digital transformation to successfully create, deliver, and consume data services that power your business. Learn more at netapp.com/services.

About NetApp

NetApp is the data authority for hybrid cloud. We provide a full range of hybrid cloud data services that simplify management of applications and data across cloud and on-premises environments to accelerate digital transformation. Together with our partners, we empower global organizations to unleash the full potential of their data to expand customer touchpoints, foster greater innovation and optimize their operations. For more information, visit www.netapp.com. #DataDriven

Table 1) FAS8200 technical specifications

Scale-Out

	FAS8200
NAS Scale-Out: 1–24 Nodes (12 HA Pairs)	
Maximum drives (HDD/SSD)	5,760/2,880
Maximum raw capacity	57PB
Maximum onboard Flash Cache based on NVMe technology	48TB
Maximum Flash Pool	864TB
Maximum memory	3072GB
SAN Scale-Out: 1–12 Nodes (6 HA Pairs)	
Maximum drives (HDD/SSD)	2,880/1,440
Maximum raw capacity	28PB
Maximum onboard Flash Cache based on NVMe technology	24TB
Maximum Flash Pool	288TB
Maximum memory	1536GB
Cluster interconnect	2 10GbE

Per HA Pair Specifications (Active-Active Dual Controller)

	FAS8200
Maximum drives (HDD/SSD)	480/480
Maximum raw capacity	4800TB
Maximum onboard Flash Cache based on NVMe technology	4TB
Maximum Flash Pool	72TB
Controller form factor	3U
ECC memory	256GB
NVRAM	16GB
PCIe expansion slots	4
Onboard I/O: UTA 2 (8Gb/16Gb FC, GbE/10GbE, or FCVI ports [MetroCluster only])	8
Onboard I/O: 10GbE	4
Onboard I/O: 10GbE Base-T	4
Onboard I/O: 12Gb SAS	8
OS Version: ONTAP 9.1 RC1 and Later	
Shelves and media	See the Shelves and Media page1 on NetApp.com for the most current information.
Storage protocols supported	FC, FCoE, iSCSI, NFS, pNFS, CIFS/SMB
Host/client operating systems supported	Windows 2000, Windows Server 2003, Windows Server 2008, Windows Server 2012, Windows Server 2016, Windows XP, Linux, Sun Solaris, AIX, HP-UX, Mac OS, VMware, ESX

1. netapp.com/us/products/storage-systems/disk-shelves-and-storage-media/index.aspx.

Table 2) NetApp FAS8200 series software

The ONTAP 9 Base Bundle includes a set of software products that deliver leading data management, storage efficiency, data protection, and high performance. The optional Premium Bundle and extended value software products provide advanced capabilities, including instant cloning, data replication, application-aware backup and recovery, volume encryption, and data retention.

Software included in ONTAP 9 Base Bundle

The Base Bundle includes the following NetApp technologies:

- Storage protocols: all supported data protocol licenses (FC, FCoE, iSCSI, NFS, pNFS, CIFS/SMB)
- Efficiency: NetApp FlexVol™, deduplication, compression, compaction, and thin provisioning
- Availability: multipath I/O
- Data protection: RAID-TEC™, RAID DP®, and Snapshot
- Performance: adaptive QoS
- Scalable NAS container: FlexGroup
- Management: OnCommand System Manager and OnCommand Unified Manager

Software included in ONTAP 9 Premium Bundle (optional)

To add capabilities to the Base Bundle, the optional Premium Bundle includes the following NetApp technologies:

- FlexClone®: instant virtual copies with file and volume granularity
- SnapMirror: integrated data replication technology for simple, efficient, flexible disaster recovery and backup use cases
- SnapRestore®: restore entire Snapshot copies in seconds
- SnapCenter®: unified, scalable software and plug-in suite for application-consistent data protection and clone management
- SnapManager® suite: application- and virtual machine–aware backup and cloning

See NetApp.com for information about additional software available from NetApp.

Extended value software (optional)

Separate optional software, beyond the Base Bundle and Premium Bundle, is also available:

- OnCommand Insight: infrastructure analytics platform that provides optimization, troubleshooting, monitoring, and cost analysis of your IT infrastructure
- SnapLock®: compliance software for write once, read many (WORM)-protected file data
- Volume Encryption: granular, volume-level data-at-rest encryption
- FlexArray: virtualization of existing third-party storage arrays into an ONTAP environment to leverage the array storage capacity behind a NetApp FAS

FAS8200 Hybrid Flash Storage

NetApp® FAS8200 hybrid flash storage is designed for business-critical and consolidated environments that require rich data management, enterprise-grade capabilities, and scalability for SAN and NAS workloads. Built on NetApp ONTAP® data management software, it quickly responds to changing storage needs across flash, disk, and cloud.

Technology advances are changing the way businesses manage their data. Instead of considering only traditional requirements such as storage uptime, scalability, and cost efficiency, to gain a competitive advantage, IT must now consider factors such as flash acceleration, cloud integration, unified support for SAN and NAS, and simplified data mining. In addition, many businesses are held back by structural limitations in legacy storage and data architectures. Traditional storage arrays might deliver on basic needs, but result in data silos and cannot meet advanced service requirements or leverage the cloud.

The demands of a data-driven business require a new approach to data management: an integrated combination of high-performance hardware and adaptive, scalable data management software. It must support existing workloads and have the ability to adapt and scale quickly to address new applications and evolving IT models.

Accelerate Business Operations with FAS8200

FAS8200 hybrid flash arrays are designed to address businesses' needs for high-performance systems that can support existing and future workloads, SAN or NAS, plus adjust and scale quickly. The FAS8200 systems unify data management infrastructure, giving the flexibility to adapt to changing business needs while delivering on core IT requirements for uptime, scalability, and cost efficiency.

Powered by NetApp® ONTAP® data management software, the FAS8200 unifies SAN and NAS infrastructure. When hybrid-flash FAS8200 are clustered with NetApp AFF all-flash arrays and integrated with the cloud, data can easily be moved to where it is needed and be placed in the data management environment that delivers the best combination of flash performance, storage capacity, and cost efficiency.

The FAS8200 will help the State of West Virginia:

- Unleash the power of flash
- Scale seamlessly
- Achieve greater availability and nondisruptive operations
- Optimize hybrid cloud deployment
- Build the right long-term platform
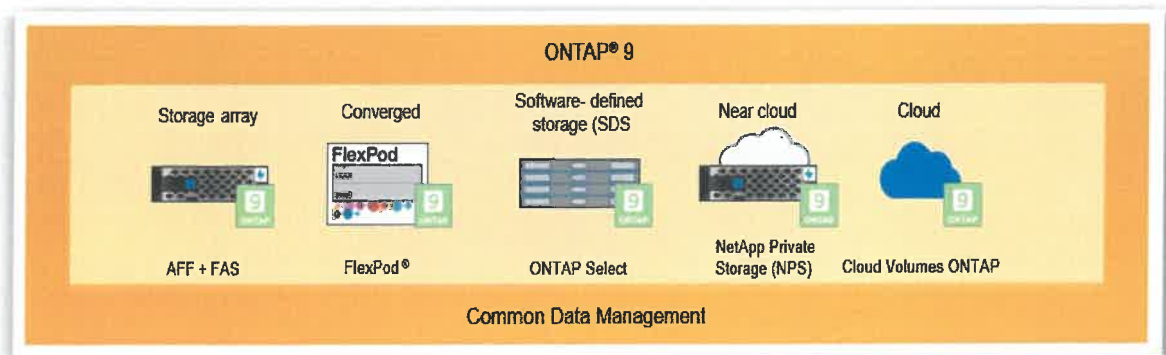
Figure 1: **Standardize data management across architectures with a rich set of enterprise data services.**

Unleash the Power of Flash

The flash-accelerated FAS8200 hybrid storage system delivers up to 50% more performance than the previous generation FAS systems, boosting throughput, lowering latency, and meeting stringent service levels.

In hybrid FAS8200 configurations, the base configuration of each HA pair includes 2TB of onboard Flash Cache™ based on NVMe technology, which can be expanded up to 4TB of integrated Flash Cache and up to 72TB of total flash per HA pair when leveraging Flash Pool™ intelligent data caching. Hot data is automatically promoted to flash in real time, so you receive the full benefit of flash performance.

Scale Seamlessly

For many IT organizations, adding capacity can be disruptive and result in multiple storage systems, silos of data, orphaned capacity, and increased complexity. Unlike other scale-out options, NetApp gives you the ability to scale your data management environment in the way that makes the most sense for your business needs. You gain greater flexibility to address specific capacity and performance requirements to optimize and accelerate your data management environment.

With the FAS8200, you can:

- Scale up by adding capacity, adding flash acceleration, and upgrading controllers
- Scale out by growing from 2 nodes up to a 24-node cluster with 57PB of capacity, including combinations of different FAS and AFF models

In addition, FAS8200 supports very large NAS containers with the NetApp FlexGroup feature of ONTAP 9, by creating a single namespace that can scale up to 20PB and 400 billion files with consistent high performance and resiliency.

With the ability to nondisruptively add and replace data management systems and components, scaling occurs without maintenance windows or the challenge of coordinating downtime across teams. Updates can be performed during regular work hours.

ONTAP 9

Scale out by adding controllers

Scale up individual controllers

NetApp® AFF   AFF   NetApp FAS   Next-generation SSDs   Cloud Volumes ONTAP®   ONTAP Select
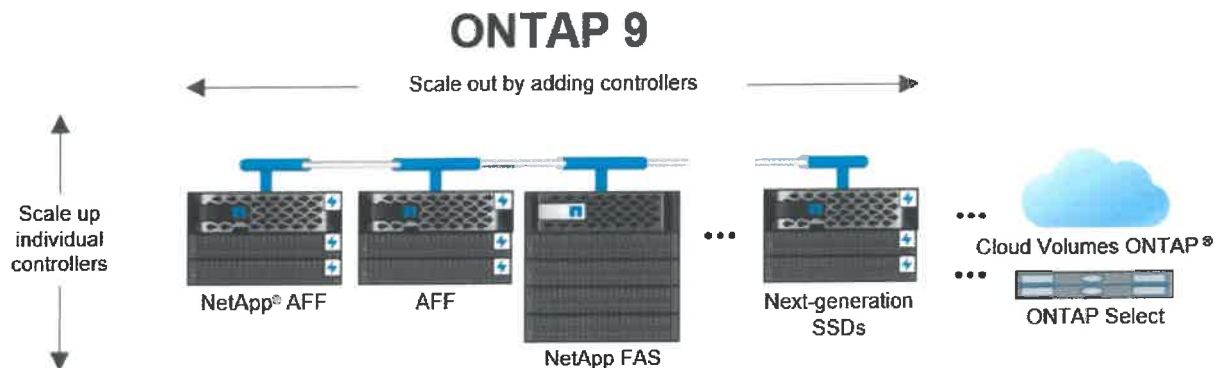
Figure 2:   Scale seamlessly – *Unified scale-out storage lets you grow your data management environment in the way that makes the most sense for your needs.*

A storage environment is typically refreshed every three to five years, resulting in significant disruption and expense. With NetApp FAS storage, you can combine different hardware generations. Therefore, you can add new storage systems and retire older ones from a cluster without negatively affecting operations.

Achieve Greater Availability and Nondisruptive Operations

FAS8200 hybrid flash storage is engineered to meet demanding availability requirements. All models are designed to deliver 99.9999% availability or greater through a comprehensive approach that combines highly reliable hardware, innovative software, and sophisticated service analytics. Software and firmware updates, hardware repair and replacement, load balancing, and tech refresh can be completed without planned downtime.

In addition, NetApp Integrated Data Protection technologies protect your data, accelerate recovery, and integrate with leading backup applications for easier management. Our advanced service analytics software prevents issues from becoming outages. Risk signatures are constantly monitored, and administrators and/or NetApp service staff are alerted to proactively address issues that might affect operations.

With the cloud-based predictive analytics and proactive support of NetApp Active IQ®, you can optimize your data infrastructure. You can also prevent problems, save time, and gain insight by leveraging machine learning to get real-time predictions and recommendations based on community wisdom from NetApp's large user base.

NetApp MetroCluster™, a simple-to-manage business continuity solution, expands data protection to eliminate risk of data loss by synchronously mirroring data between locations for continuous availability of information. With NetApp MetroCluster, you can automate failover to minimize downtime and the possibility of human error. A MetroCluster storage array can exist in a single data center or in two different data centers that are located across a campus, across a metropolitan area, or in different cities. Your data is protected from loss and is continuously available to meet the most business-critical needs.

Plus, MetroCluster solutions based on the FAS8200 offer enhanced configuration flexibility from the new controller architecture, which moves Flash Cache intelligent data caching from the PCIe slots to the motherboard and adds FCVI connectivity to the onboard UTA2 ports.
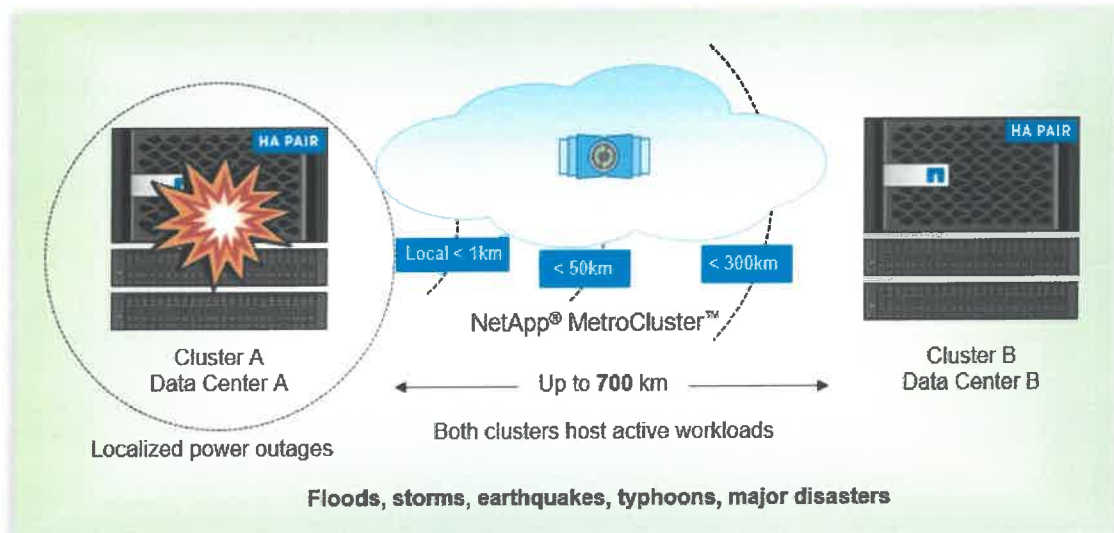
Figure 3:   MetroCluster extends nondisruptive operations beyond the data center.

Optimize Hybrid Cloud Deployment

Organizations are now focusing on service-oriented IT architectures in which cloud IT models are leveraged to enhance return on investment and assets. The FAS8200 is an excellent platform for cloud because it combines the features needed for a successful private cloud deployment along with the capabilities that make it easier to leverage the capabilities of cloud service providers and hyperscale cloud providers.

FAS8200 running ONTAP is optimized for private and hybrid cloud requiring secure multitenancy, storage quality of service (QoS), nondisruptive operations, and easily defined tiers of service. Burst your analytics and DevOps workloads to the cloud by connecting your FAS8200 to NetApp Cloud Volumes, the first enterprise-class native file service available in major hyperscalers.
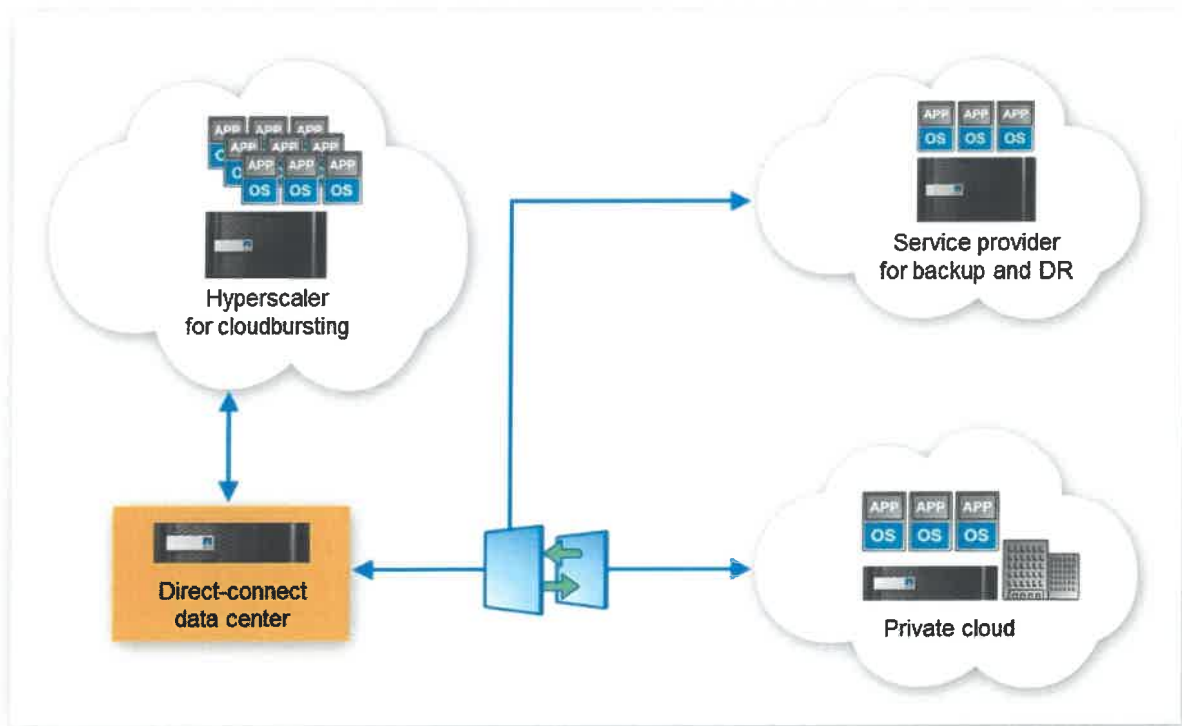
Figure 4: FAS8200 is the cornerstone of cloud services – *Optimized for the cloud so you can confidently transition to a hybrid cloud.*

For maximum flexibility, Cloud Volumes ONTAP—a version of ONTAP that runs in Amazon Web Services (AWS) and Azure—provides the storage efficiency, availability, and scalability of ONTAP, and it allows quick and easy movement of data between on-premises FAS8200 and AWS/Azure environments with NetApp SnapMirror® data replication software.

For organizations requiring an enterprise-class hybrid cloud with predictable performance and availability, the FAS8200 can be used in a NetApp Private Storage (NPS) for Cloud solution. With NPS for Cloud, you can directly connect to multiple clouds using a private, high-bandwidth, low-latency connection. You can connect to industry-leading clouds such as AWS, Microsoft Azure, or IBM Cloud and switch between them, while maintaining complete control of data on your dedicated, private FAS8200. You gain the elasticity of the public cloud while protecting your data with NetApp.

Build the Right Long-Term Platform

Flexibility for adapting to future requirements, simplifying your data management environment, and total cost of ownership are important components of a long-term infrastructure investment. FAS8200 provides a significant price/performance benefit. By using our leading storage efficiency technologies such as inline deduplication, inline compression, inline compaction, thin provisioning, and Snapshot® technology, you can increase disk utilization, reclaim stranded storage capacity, and increase total return on investment.

Easily and efficiently protect at-rest data by encrypting any volume and any disk on FAS (and AFF) systems with NetApp Volume Encryption. No special encrypting disks are required.
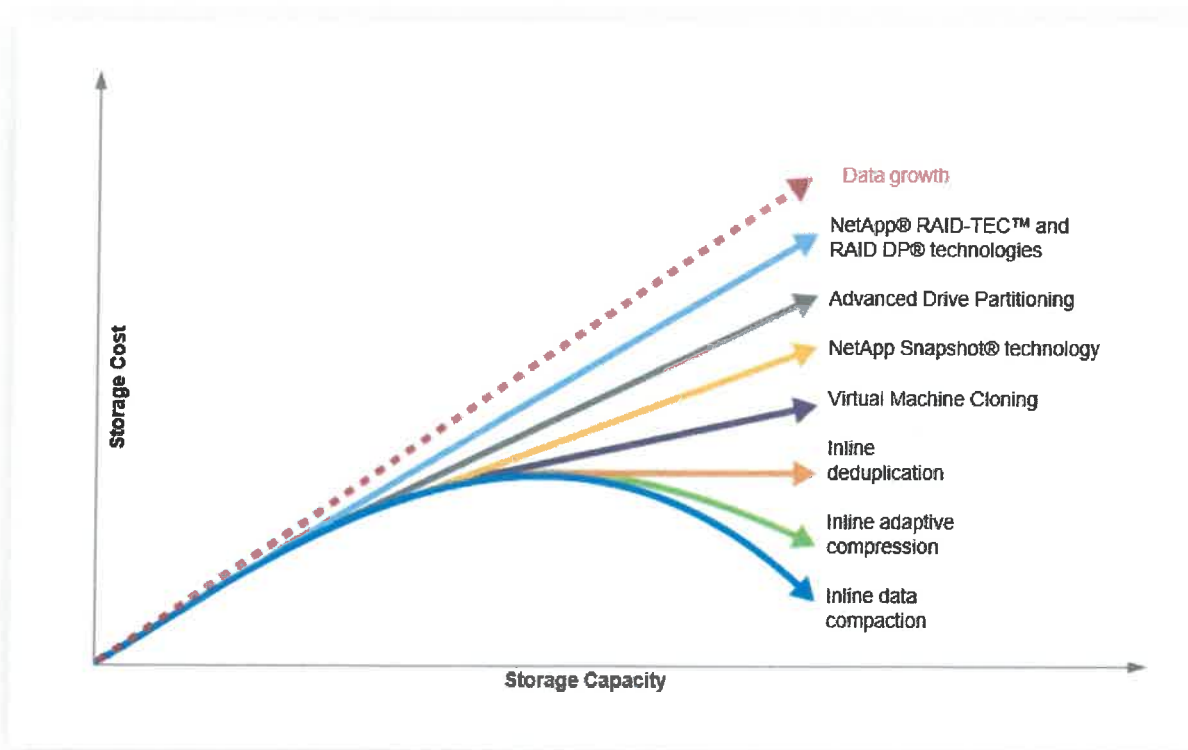
Figure 5: **Lower capital expenditures and operational expenditures** – *Doing more with less, using one the world's leading efficiency portfolio.*

In a data-driven business, many companies also need to increase their operations' effectiveness through the ability to leverage data for competitive advantage and to assign resources dynamically. The NetApp ONTAP data management software portfolio is composed of automation, integration, device-level management, and enterprise storage resource management products for use with the FAS8200.

Achieve Greater Business Value from Your Investment

Whether you are planning your next-generation storage system, need specialized know-how for a major storage deployment, or want to optimize the operational efficiency of your existing infrastructure, NetApp Services and our certified partners can assist you.

Each of the following enablement services can be deployed individually or in combination to realize greater business and technical value from your NetApp products and solutions:

- Strategy and Design Services
- Deploy and Transition Services
- Operations Services
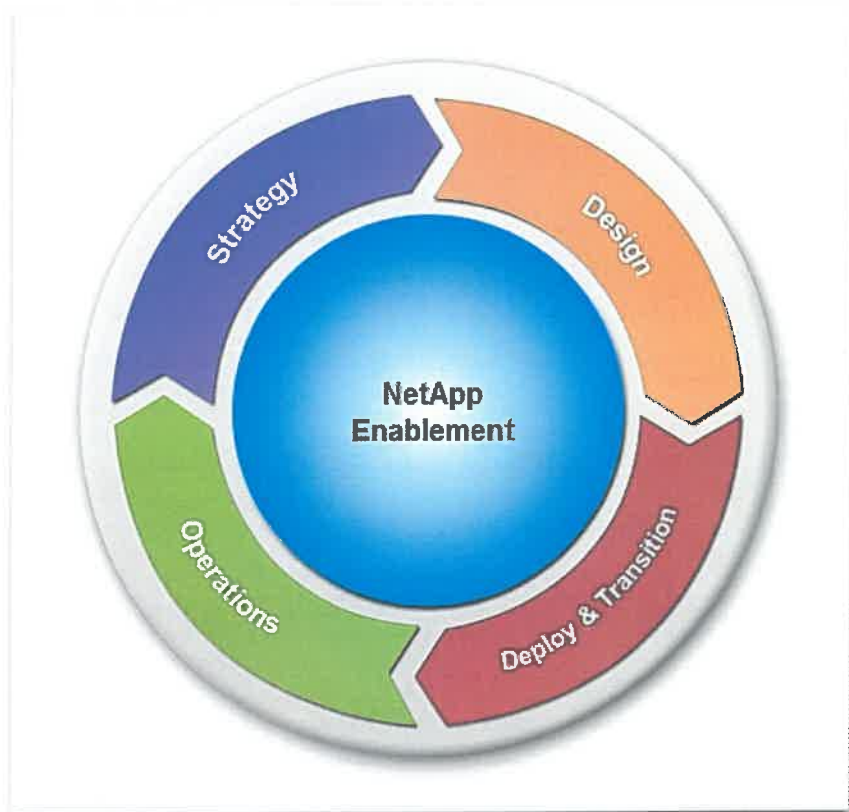
Figure 6: **IT lifecycle** – *Our extensive experience in migrating enterprise storage architecture, combined with our project management skill and array of NetApp hardware and software certifications, places you in excellent hands, wherever the company is in the lifecycle.*

Technical Specifications

Table 1: **FAS8200 technical specifications.**

FAS8200 Technical Specifications

Use

Business-critical and consolidated environments that require rich data management, enterprise-grade capabilities, and scalability for SAN and NAS workloads; Midsize businesses and enterprises of all sizes that need high performance, availability, scalability, and agility.

NAS Scale-Out	1–24 nodes (12 HA pairs)
Maximum drives (HDD/SSD)	5,760/2,880
Maximum raw capacity	57PB
Maximum onboard Flash Cache™ based on NVMe technology	48TB

FAS8200 Technical Specifications

Maximum Flash Pool	864TB
Maximum memory	3072GB
SAN Scale-Out	1–12 nodes (6 HA pairs)
Maximum drives (HDD/SSD)	2,880/1,440
Maximum raw capacity	28PB
Maximum onboard Flash Cache based on NVMe technology	24TB
Maximum Flash Pool	288TB
Maximum memory	1536GB
Cluster Interconnect	210GbE

Specifications per HA Pair (Active-Active Dual Controller)

Maximum drives (HDD/SSD)	480/480
Maximum raw capacity	4800TB
Maximum onboard Flash Cache based on NVMe technology	4TB
Maximum Flash Pool	72TB
Controller form factor	3U
ECC memory	256GB
NVRAM	16GB
PCIe expansion slots	4
Onboard I/O: UTA 2 (8Gb/16Gb FC, GbE/10GbE, or FCVI ports [MetroCluster only])	8
Onboard I/O: 10GbE	4
Onboard I/O: 10GbE Base-T	4
Onboard I/O: 12Gb SAS	8
OS version	ONTAP 9.1 RC1 and later
Shelves and media	See the Shelves and Media page[1] on NetApp.com for the most current information
Storage protocols supported	FC, FCoE, iSCSI, NFS, pNFS, SMB/CIFS

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[1] www.netapp.com/us/products/storage-systems/disk-shelves-and-storage-media/index.aspx.

Host/client operating systems supported	Windows 2000, Windows Server 2003, Windows Server 2008, Windows Server 2012, Windows Server 2016, Windows XP, Linux, Oracle Solaris, AIX, HP-UX, Mac OS, VMware, ESX

Simplified Software

NetApp FAS8200 systems run on ONTAP data management software. The ONTAP 9 Base Bundle includes a set of software products that deliver leading data management, storage efficiency, data protection, and high performance. The optional Premium Bundle and extended value software products provide advanced capabilities, including instant cloning, data replication, application-aware backup and recovery, volume encryption, and data retention.

Table 2:   NetApp FAS8200 series software.

FAS8200 Series Software

Software included in ONTAP 9 Base Bundle	The Base Bundle includes the following NetApp technologies: **Storage protocols:** All supported data protocol licenses are included (FC, FCoE, iSCSI, NFS, pNFS, SMB/CIFS) **Efficiency:** NetApp FlexVol® technology, deduplication, compression, compaction, and thin provisioning **Availability:** Multipath I/O **Data protection:** NetApp RAID-TEC™, RAID DP technology, and Snapshot™ technologies **Scalable NAS container:** NetApp ONTAP FlexGroup **Management:** ONTAP System Manager and Active IQ Unified Manager
Software included in ONTAP 9 Premium Bundle (optional)	To add capabilities to the Base Bundle, the optional Premium Bundle includes the following NetApp technologies: **FlexClone® technology:** Data replication technology for instant virtual copies of databases or virtual machines **SnapMirror:** Simple, efficient, flexible disaster recovery **SnapRestore® software:** Data-recovery software to restore entire Snapshot copies in seconds **SnapCenter® technology:** Unified, scalable platform and plug-in suite for application-consistent data protection and clone management **SnapManager® software:** Suite for application- and virtual machine–aware backup, recovery, and cloning
Extended-value software (optional)	Separate optional software, beyond the Base Bundle and Premium Bundle, is also available: **OnCommand Insight:** Provides infrastructure analytics platform that provides optimization, troubleshooting, monitoring, and cost analysis of your IT infrastructure

NetApp SnapLock® technology: Compliance software for write once, read many (WORM)–protected data

NetApp Volume Encryption: Granular, volume-level data-at-rest encryption

All Flash FAS

NetApp® All Flash FAS (AFF) is an all-flash array that delivers high performance, flexibility, low latency, and superior data management without sacrificing enterprise capabilities. AFF enables a smooth transition to flash for your data center, built on NetApp ONTAP® data management software.

As businesses go through digital transformation, they must modernize their IT infrastructure to improve speed and responsiveness to support critical business operations. Although all-flash storage systems have been widely adopted to accelerate typical enterprise applications, newer workloads such as data analytics, artificial intelligence (AI), and deep learning—demand higher performance that first-generation flash systems cannot deliver.

In addition, as more organizations adopt a "cloud first" strategy, it is critical to offer enterprise-grade data management capabilities for a shared environment across on-premise data centers and the cloud. Many all-flash array solutions available today lack robust data management, integrated data protection, seamless scalability, new levels of performance, deep application, and cloud integration.

Cloud-Connected All-Flash Storage Powered by ONTAP

NetApp® All Flash FAS (AFF) is a robust scale-out platform built for virtualized environments, combining low-latency performance with comprehensive data management, built-in efficiencies, integrated data protection, multiprotocol support, and nondisruptive operations.
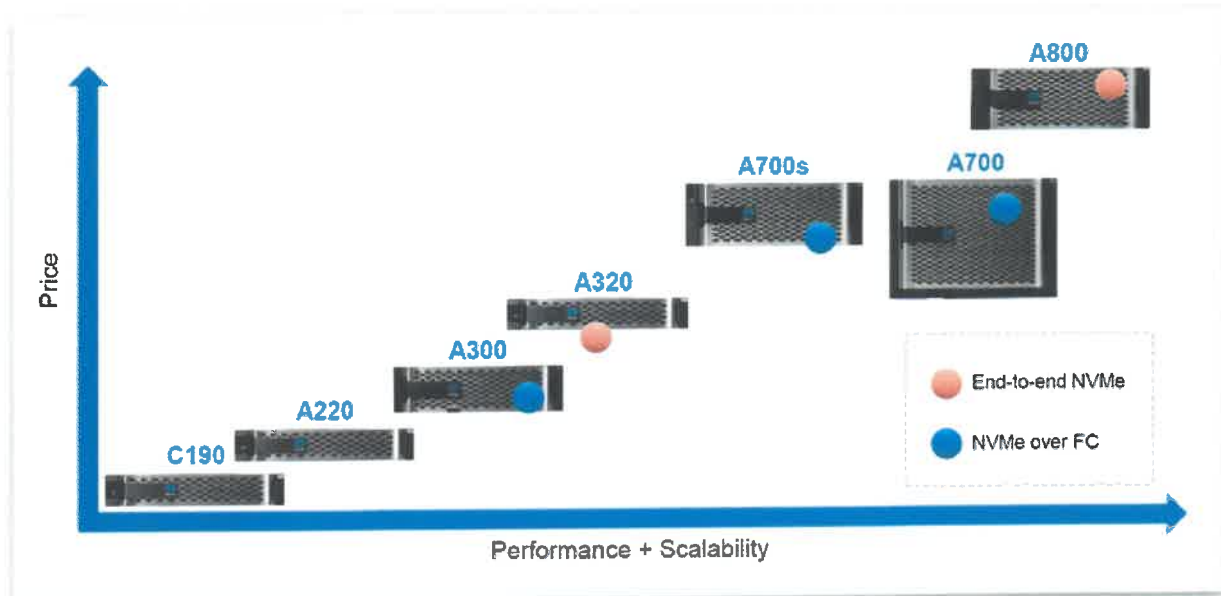
Figure 1:   AFF portfolio – *Modernize with cloud connected flash; provides solutions to modernize IT for small to large enterprises.*

"We're able to fit a whole lot more in a smaller amount of space and still provide more performance than we had before."

— CI Engineer, financial services firm

NetApp AFF A-Series systems are designed to help businesses accelerate infrastructure transformation and fuel data-driven strategies. Powered by NetApp ONTAP® data management software, AFF systems accelerate, manage, and protect business-critical data and give you an easy and smooth transition to flash for your digital transformation in the hybrid cloud. With AFF systems, you can:

- Increase operational efficiency
- Accelerate applications and future-proof your infrastructure
- Keep business-critical data available, protected, and secure.

Increase Operational Efficiency

AFF offers the broadest application ecosystem integration for enterprise application, such as virtual desktop infrastructure (VDI), database, and server virtualization—supporting Oracle, Microsoft SQL Server, VMware, SAP, MySQL, and more. Infrastructure management tools simplify and automate common storage tasks so that you can:

- Provision and rebalance workloads by monitoring clusters and nodes
- Use one-click automation and self-service for provisioning and data protection
- Import LUNs from third-party storage arrays directly into an AFF system to seamlessly migrate data

In addition, with the NetApp Active IQ® intelligence engine you can optimize your NetApp systems with predictive analytics and proactive support tool, provide real-time insights and recommendations to prevent problems and optimize your data infrastructure.

"With the NetApp solution, we can slash the time needed to create an environment from 6 hours to 5 minutes regardless of scale, while provisioning additional environments simultaneously. That translates to a time savings of 70% for each product line."

— Sandrine Kalk |Director of Global DevOps and Operations, Verint
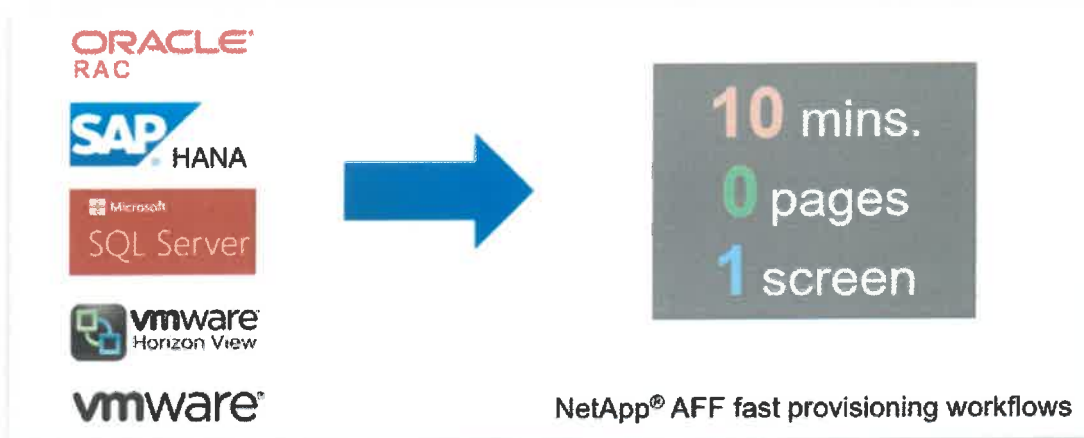
Figure 2: Application-aware data management -- *Deploy key workloads in less than 10 minutes with ONTAP System Manager.*

## Achieve Storage Savings, Backed by the Industry's Most Effective Guarantee

With AFF, reduce your data center costs with the best effective capacity for any workload, backed by the industry's most effective guarantee. We guarantee in writing:

- 3:1 guarantee across all workloads
- 4:1 for VVOL and 8:1 for VDI
- Use snapshots and get 10x higher efficiency

AFF system's support for solid state drives (SSDs) with multistream write technology, combined with advanced SSD partitioning, provides maximum usable capacity, regardless of the type of data that you store. Thin provisioning; NetApp Snapshot™ copies; and inline data reduction features, such as deduplication, compression, and compaction, provide additional space savings—without affecting performance—so you can purchase the least amount of storage capacity possible.

Build your Hybrid Cloud with Ease

The NetApp Data Fabric helps you simplify and integrate data management across cloud and on-premises to meet business demands and gain a competitive edge. With AFF, you connect to more clouds for more data services, data tiering, caching, and disaster recovery. FabricPool gives you the ability to move data automatically between AFF and the cloud storage tiers to maximize performance and reduce overall data management cost. Simplify hybrid cloud backup and recovery with cloud-resident NetApp Data Availability Services and accelerate read performance for data that is shared throughout your organization and across hybrid cloud deployments.
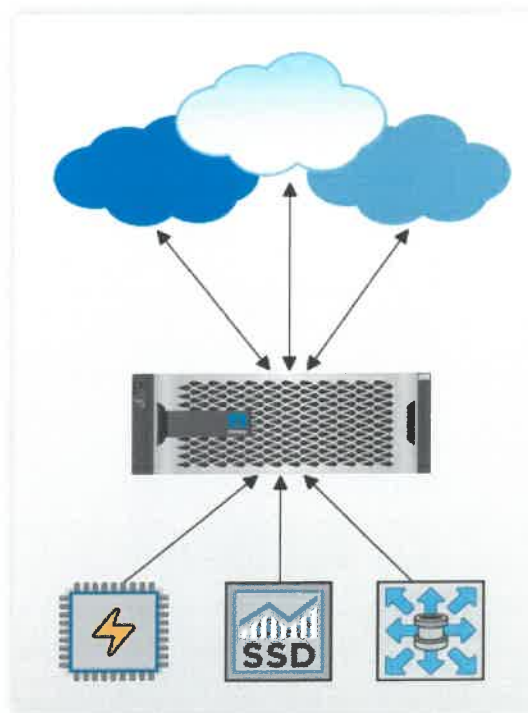

Figure 3: Future-proof your infrastructure with the most cloud-connected all-flash array – *Designed for the cloud era to connect to more clouds, in more ways, and to more services—to virtually any service provider or private cloud.*

Accelerate Applications and Future-Proof Your Infrastructure

NetApp AFF systems deliver industry-leading performance proven by SPC-1[1] and SPEC SFS industry benchmarks, making them ideal for demanding, highly transactional applications such as Oracle, Microsoft SQL Server, MongoDB databases, VDI, and server virtualization. The AFF A800 system achieved:

- 2,401,000 SPC-1 IOPS at 0.590 SPC-1 IOPS Response Time in a new SPC-1v3 result
- Lowest latency and $/GB among the top 5 results
- Predictable and consistent latency
  - ~0.4ms latency @ 80% load
  - 0.351ms SPC-1 Overall Response Time
- Highest storage capacity utilization
  - 66% versus ~30% from most others
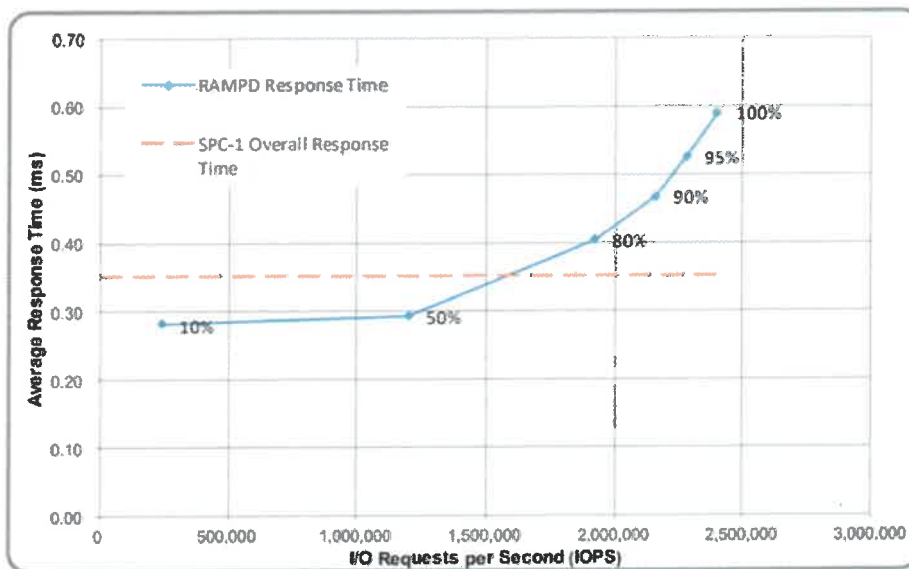
Figure 4: **AFF A800 Places in the Top 4 of SPC-1v3** – *Best performance and value among major vendors who publish benchmarks.*

Accelerate Demanding Workloads

Accelerate the most demanding workloads with an AFF A800 and AFF A320 system. The AFF A800 combines NVMe SSDs and NVMe/FC connectivity to provide an ultrafast end-to-end data path to your applications. The midrange AFF A320 system supports NVMe/RoCE connectivity on the backend to the NVMe drive shelf and NVMe/FC on the front-end to the host. The AFF A320 leads the market with the best combination of NVMe-oF technologies.

Consolidate all workloads on AFF systems, which deliver up to 11.4 million IOPS at lms latency in a cluster with a truly unified scale-out architecture. You can manage a scalable NAS container of up to 20PB and 400 billion files with a single namespace by using NetApp FlexGroup volumes, while maintaining consistent high performance with adaptive quality of service (QoS) and resiliency. NetApp FlexCache® software improves the speed and productivity

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[1] Link to SPC-1 report: http://spcresults.org/benchmarks/results/spc1-spc1e#A32007.

of collaboration across multiple locations and increases data throughput for read-intensive applications.

Modernize with Advanced NVMe

Designed specifically for flash, the AFF A-Series all-flash systems deliver industry-leading performance, capacity density, scalability, security, and network connectivity in dense form factors. AFF A-Series systems support NVMe/FC host connectivity, so you can gain twice the IOPS and cut application response time in half compared with traditional FC. These systems support a range of ecosystems, including VMware, Microsoft Windows 10, and Linux, with storage path failover. For most customers, integrating NVMe/FC into an existing SAN is a simple, nondisruptive software upgrade.

In addition, integrate new technologies and private or public cloud into your infrastructure nondisruptively. AFF is the only all-flash array where you can combine different controllers, SSD sizes, and new technologies—protecting your investment.

Keep Important Data Available, Protected, and Secure

Support backup and disaster recovery needs through our complete suite of integrated data protection and replication features. NetApp Integrated Data Protection technologies protect data and accelerate recovery; for easier management they integrate with leading backup applications. Benefit from features and capabilities such as NetApp Snapshot™ copies, cloning, encryption, and both synchronous and asynchronous replication for backup and disaster recovery. Key capabilities and benefits include:

- Reduced data management costs with native space efficiency with cloning and NetApp Snapshot copies. Up to 1,023 copies are supported.

- Unified, scalable platform and plug-in suite for application-consistent data protection and clone management with NetApp SnapCenter®.

- Reduced overall system costs with NetApp SnapMirror® replication software, which replicates to any type of FAS/AFF system: all-flash, hybrid, or HDD, on the premises or in the cloud.

- Synchronous replication with NetApp MetroCluster™ software, a capability in the all-flash-array market that delivers zero RPO and low to zero RTO for mission-critical workloads.

- Regulatory compliance with NetApp SnapLock® technology, which is enabled with Integrated Data Protection and storage efficiency.
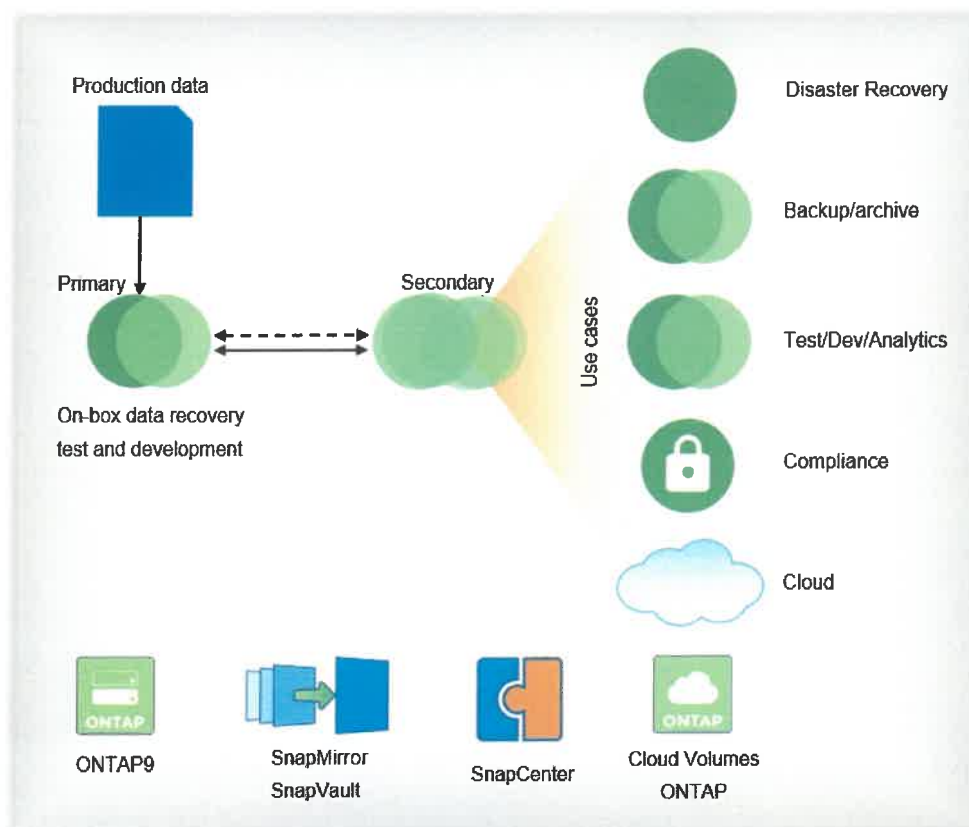
Figure 5: **NetApp integrated data protection** – *Offers one data management flexible platform that provides data availability to keep applications running, mitigate risk, control costs, and improve data protection processes.*

In addition, flexible encryption and key management help guard sensitive data on the premises, in the cloud, and in transit. With the simple and efficient security solutions, you can:

- 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 secure purge; logging and auditing monitors; and write once, read many (WORM) file locking.

- Protect against threats with multifactor authentication, role-based access control, secure multitenancy, and storage-level file security.

> *"NetApp's multiprotocol capability was a major draw for our colleges. With NetApp, we can enable our colleges to retain their skillsets. They don't have to learn something new or put in a mix of products just to accommodate their protocols."*
>
> — *Daniel Black |Director of Engineering, Technical College System of Georgia*

Future-Proof Your Investment with Maximum Flexibility

NetApp solutions establish a seamless, well-integrated hybrid cloud architecture or Data Fabric that easily ties together private cloud, service providers, and hyperscale cloud providers along with their data management environments. This Data Fabric gives you the ability to implement the hybrid cloud on its own terms. Move data and applications to an AFF system, on commodity hardware with software-defined storage, or in the cloud. The Data Fabric offers a broad set of application ecosystem integration for database, VDI, and server virtualization.

With AFF, which is Data Fabric ready, your investment is protected as performance and capacity needs change or your cloud strategy evolves:

- AFF systems eliminate performance silos. Seamless integration with hybrid FAS systems means that workloads can transparently move between high-performance tiers and low-cost capacity tiers.

- Seamlessly adapt to changing needs with the only all-flash array that offers the ability to intermix different controllers, SSD sizes, and next-generation technologies.

- AFF is data fabric ready, with proven cloud connectivity. FabricPool enables you to move data automatically between AFF and the cloud storage tiers to maximize performance and reduce overall data management cost.

- Optimize data management for enterprise workload environments with leading application integration with Oracle, Microsoft, VMware, SAP, OpenStack, and many more.
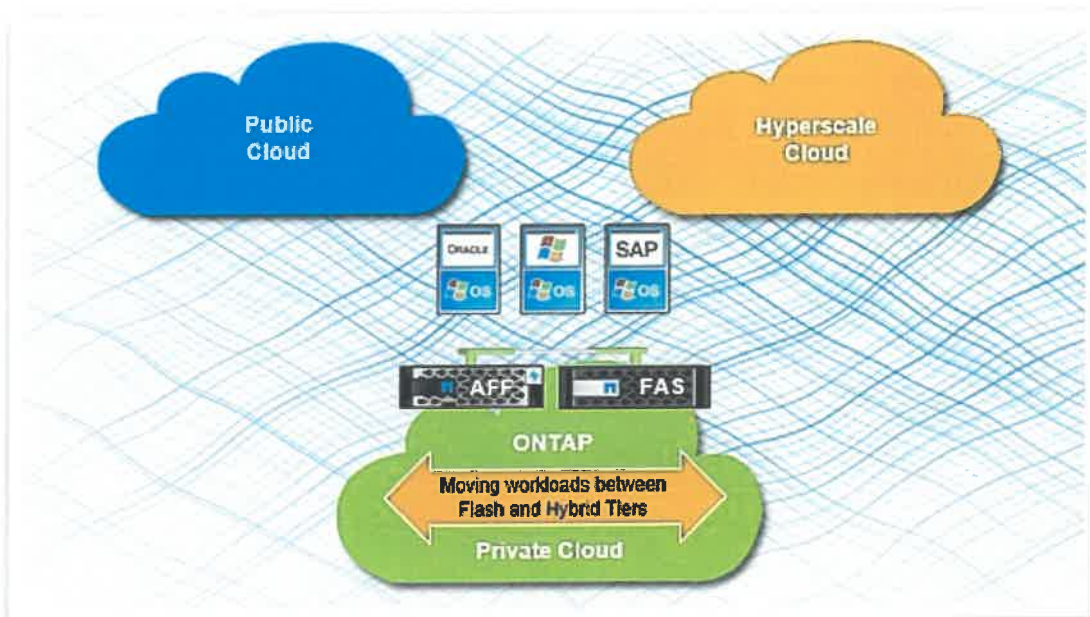
Figure 6:   AFF is Data Fabric ready—moving data between tiers and different clouds.

"With NetApp All Flash FAS, we can improve the quality of healthcare in our own hospitals and others throughout the region by offering high-performing electronic patient records and virtual desktops to healthcare providers."

— Reinoud Reynders, IT Manager, Infrastructure and Operations at UZ Leuven

All-Flash Performance Powered by End-to-End NVMe Technology

AFF systems are excellent for performance-demanding applications and mixed-workload environments that consist of, for example, Oracle, Microsoft SQL Server, MongoDB databases, VDI, and server virtualization. With NVMe-based AFF A800, AFF is also a great choice for AI and deep-learning environments:

- Combined with ONTAP cloud integration and software-defined capabilities, AFF enables the full range of the data pipeline that spans the edge, the core, and the cloud for AI and deep learning, leveraging the same ONTAP data management.

- The end-to-end NVMe-based AFF A800 delivers 1.3 million IOPS at below 500µs latency.

- Built-in adaptive QoS safeguards SLAs in multiworkload and multitenant environments. It optimizes performance control dynamically with superior scalability of up to 40,000 workloads per cluster at LUN, file, and VVol levels.

- With the latest ONTAP release, AFF delivers up to 90% performance increase for Microsoft SQL Server with multichannel SMB.

Storage Efficiency Technologies

NetApp is known for its superior storage efficiency technologies, such as inline deduplication, inline compression, thin provisioning, and space-efficient Snapshot copies. These technologies apply to AFF systems and further reduce your total cost of ownership by lowering cost per effective gigabyte of storage:

- Performance-efficient inline data reduction technologies provide an average of 5 to 10 times space savings for a typical use case.

- Space-saving inline data compaction technology places multiple logical data blocks from the same volume into a single 4KB block. Space savings as high as 67:1 from this feature have been observed when using inline data compaction and inline compression with an Oracle database.

- There is a near-zero performance impact with inline compression. Incompressible data detection eliminates wasted cycles.

- You can increase space savings by eliminating redundant blocks using inline deduplication—effective for operations such as VDI OS patches in which this deduplication can achieve 70:1 reduction rates.

- As the first all-flash array to support SSDs with MSW technology, and combined with advanced SSD partitioning in ONTAP, AFF further increases usable capacity by up to 42%.

NetApp Simplifies Management

NetApp management software provides automated tools to further simplify management of storage operations:

- Set up and configure AFF quick and easy with preconfigured systems for SAN and NAS deployments. It takes less than 10 minutes with ONTAP System Manager.

- OnCommand Workflow Automation automates common storage tasks such as provisioning and data protection. It provides fast one-click automation and self-service.

- To optimize storage for peak performance and to keep everything running smoothly, OnCommand Performance Manager provisions and rebalances workloads by monitoring clusters and nodes to assure performance headroom.

- Import LUNs from storage arrays that are not based on ONTAP software directly into an AFF system to seamlessly migrate data from older storage arrays.
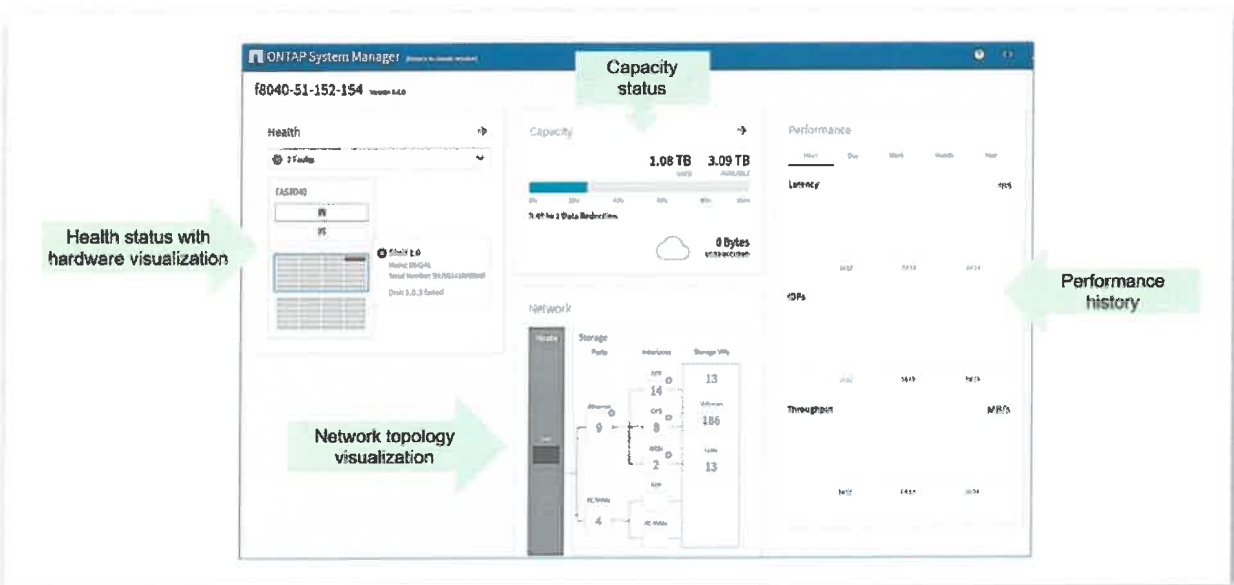
Figure 7: Intuitive ONTAP System Manager –*Based on REST APIs, the new System Manager dashboard is more intuitive and displays richer information in a more actionable view.*

Get More Business Value with Services

To help you fully realize the benefits of NetApp solutions, NetApp Services and our NetApp certified services partners will collaborate with you through a full portfolio of services that covers the company's IT lifecycle. NetApp offers:

- Assessment services to evaluate the performance and efficiency of workloads across heterogeneous environments

- Advisory services to determine the best workload candidates to move to flash

- Deploy and optimize services to prepare your environment and deliver continuous operation of AFF systems

- Managed upgrade services to secure your storage environment and to protect your investment by ensuring your ONTAP software is the most current version.

NetApp Support offerings, such as the NetApp Active IQ® cloud-based predictive cloud-based analytics and proactive support tool, provide real-time insights and recommendations to prevent problems and optimize your data infrastructure. Learn more at netapp.com/services.

AFF A-Series Systems

NetApp AFF systems help you meet your enterprise storage requirements with the following AFF A-Series Systems:

AFF A800

The AFF A800 is designed for the most demanding workloads requiring ultra-low latency and is the first flash array on the market to support NVMe SSDs and NVMe over Fabrics (NVMe-oF). It provides end-to-end NVMe connectivity between storage arrays and host servers for maximum bandwidth, high IOPS, and the lowest possible latency. Each 4U chassis accommodates dual controllers for high availability (HA) and includes 48 slots for NVMe SSDs. In addition to 32Gb and 16Gb FC, network options include the storage industry's first 100GbE connectivity, as well as 40GbE and 10GbE. An NVMe-powered SAN scale-out cluster supports up to 12 nodes (6 HA pairs) with 1,440 drives and nearly 160PB of effective capacity. NAS scale-out clusters support up to 24 nodes (12 HA pairs). The AFF A800 future-proofs your data infrastructure with NetApp ONTAP 9 the industry's leading data management software.

> *"NetApp once again hits it out of the park with the enterprise focused A800. The performance profile is very strong, taking its position at the top of the ONTAP family."*
>
> *— StorageReview Editors' Choice, May 2019*

AFF A700

The AFF A700 is a high-end NetApp storage controller designed for performance-driven workloads and data centers requiring a modular design. The AFF A700 can dramatically enhance performance and high-performance I/O density in a new 8U HA form factor and it includes options for 40GbE and 32Gb FC along with the latest in SAS connectivity, the SAS 3.0 standard with 12Gb speeds. This controller also provides the most versatile I/O interface available, the UTA2 connections that support 10GbE and 16Gb FC and that can be easily changed between these two protocols in the field. AFF A700 controllers support up to 12 nodes for SAN deployments and up to 24 nodes in NAS deployments.

AFF A700s

The AFF A700s is an integrated high-end all-flash array and best for performance-driven workloads and data centers requiring a small footprint. The AFF A700s comes in a compact form factor with dual controllers and 24 internal SSDs in a single 4U chassis. A700s provides data center efficiencies and excellent performance with reduced power and cooling. AFF A700s performance is comparable to that of AFF A700; however, they offer different connectivity and capacity options to address different solutions and customer requirements.

AFF A320

The AFF A320 midrange end-to-end NVMe NetApp AFF storage controller is a modern NVMe Flash storage system. It provides application performance improvements with lower low latencies compared to the AFF A300. For enterprise applications that require the best performance at value, the AFF A320 includes dense 2U form factor with two HA controllers, extreme bandwidth with 16 onboard 100GbE ports and four expansion slots in an HA pair, adapter support includes100GbE, 32Gb FC, 25GbE, and 10GbE support, NVDIMMs for persistent write cache of data received but not yet committed to flash media, and host-side NVMe/FC support for low-latency, high-performance remote direct memory access (RDMA) connectivity to the NVMe SSDs.

AFF A300

The A300 firmly targets enterprise applications that require best balance of performance and cost. It is more powerful than the AFA A220 for users that need additional capacity and performance The AFF A300 is easy to set up and runs the latest version of ONTAP and supports SSDs up to 30TB. It requires just 12 SSDs to start but scales to over 140PB raw (560PB effective) in NAS config and 70PB raw (280PB effective) as SAN. The A300 supports 10GbE, 40GbE as well as Fibre Channel up to 32Gb and NVMe/FC with the 32Gb FC adapter.

The midrange AFF A300 recently won the Editor's Choice Award from StorageReview, which bestows this award for "performance in excess of competitive offerings, a feature set that is innovative and sets a new bar for competitive offerings or for defining a new category or space within enterprise IT". Through Storage Review's independent testing with Oracle, SQL, VDI workloads, AFF A300 stands out with its impressive performance and feature set.

— StorageReview Editors' Choice, November 2018

AFF A220

The AFF A220 is ideal for mid-size business and small enterprises that require simplicity and best value. With the AFF A220 you can accelerate business insights and demanding workloads. This 2U array enables enhanced storage efficiency based on the types of workloads. With a potential maximum raw capacity of up to 48.3 PB and maximum memory of 768 GB, NetApp ensures the effectiveness of its inline data reduction technologies, including compression, deduplication and data compaction. It offers 4x 10 GbE cluster interconnect channels for distribution of the processing across an array of nodes in the clusters, and high-data rate and low-latency communication between node processes.

"In addition to accelerating every application without disruption, the NetApp AFF A200 dramatically improves data center economics and enables data-driven enterprises to modernize their infrastructures with confidence. Editor's Choice award for the NetApp AFF A200 for phenomenal performance at sub-millisecond latencies."

— StorageReview Editors' Choice, November 2017

AFF C-Series Systems

NetApp AFF C-Series offers entry-level all-flash systems with enterprise-grade features.

AFF C190

The NetApp AFF C190 offers an enterprise-class flash system for an affordable price. It is designed for IT generalists to meet business requirements with comprehensive data services, seamless scalability, new levels of performance, and cloud integration. With the C190 you can effortlessly connect to public clouds and automatically tier cold data or back up to the cloud to reduce overall storage costs. It delivers industry-leading hybrid cloud integration, supporting all major public clouds including Google Cloud, Amazon Web Services (AWS), Microsoft Azure, IBM Cloud, and Alibaba Cloud.

Table 1:   All Flash FAS A-Series Systems technical specifications.

AFF Technical Specifications

	AFF A800	AFF A700s	AFF A700	AFF A320	AFF A300	AFF A220
Maximum scale-out			2–24 nodes (12 HA pairs)			
Maximum SSD	2,880	2,529	5,760	576	4,608	1,728
Max effective capacity[2]	316.3PB	316.3PB	702.7PB	35PB	562.2PB	193.3PB
Per-System Specifications (Active-Active Dual Controller)						
Controller form factor	4U with 48 SSD slots	4U with 48 SSD slots	8U	2U	3U	2U with two 24 SSD slots

Table 2:   AFF A-Series software.

AFF A-Series Software

Features and software included with ONTAP software	Efficiency: NetApp FlexVol®, inline deduplication, inline compression, inline compaction, and thin provisioning
	Availability: Multipath I/O and active-active HA pair
	Data protection: NetApp RAID DP®, NetApp RAID TEC®, and Snapshot technology
	Whole cluster synchronous replication: MetroCluster
	Performance control: Adaptive QoS and balanced replacement
	Management: OnCommand Workflow Automation, ONTAP System Manager, and Active IQ Unified Manager
	Scalable NAS container: NetApp ONTAP FlexGroup
	Storage protocols supported: NVMe/FC, FC, FCoE, iSCSI, NFS, pNFS, and SMB
Flash bundle	NetApp SnapRestore® software: Restore entire Snapshot copies in seconds
	NetApp SnapMirror software: Simple, flexible backup and replication for disaster recovery
	NetApp FlexClone® technology: Instant virtual copies of files, LUNs, and volumes
	NetApp SnapCenter®: Unified, scalable platform and plug-in suite for application-consistent data protection and clone management
	NetApp SnapManager software: Application-consistent backup/recovery for enterprise applications
	Go to NetApp.com for information on additional software available from NetApp.

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[2] Effective capacity is based on 5:1 storage efficiency ratios with the maximum number of SSDs installed. The actual ratio can be higher depending on workloads and use cases.

AFF A-Series Software

Extended-value software (optional)	NetApp OnCommand Insight: Flexible, efficient resource management for heterogeneous environments
	NetApp SnapLock: Compliance software for write once, read many (WORM) protected data
	NetApp Volume Encryption (free license): Granular, volume-level, data-at-rest encryption
	NetApp FabricPool feature: Automatic data tiering to the cloud
	SnapMirror Synchronous: Synchronous data replication with zero recovery point objective
	NetApp Data Availability Services: Cloud native backup solution for ONTAP storage
	NetApp FlexCache: Acceleration for data access for single or multisite deployment

Table 3:   All Flash FAS C-Series Systems technical specifications.

AFF C190 Technical Specifications for Active-Active Dual Controller

Drives and Capacity	Connectivity	Protocols and Operating Systems
Max. effective capacity 50TiB[3]	4 ports—12Gb/6Gb SAS	ONTAP 9.6 GA or later
Max. SSD 24 drives	1GbE management port, USB port	Protocols: FC, FCoE, iSCSI, NFS, pNFS, SMB
Drive type: 960GB SSD	8 ports—FC target (16Gb) 8 ports—FCoE target, UTA2 12 ports—10GbE ports, UTA2 12 ports—10GBASE-T	Host OS version: Windows 2000, Windows Server 2003, Windows Server 2008, Windows Server 2012, Windows Server 2016, Linux, Oracle Solaris, AIX, HPE UX, macOS, VMware, ESX

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[3] Effective capacity is based on 3:1 storage efficiency ratios with the maximum number of SSDs installed. The actual ratio can be higher depending on workloads and use cases

Table 4: AFF C-Series software.

Software Included with AFF C190	
Features and software included with ONTAP software	Efficiency: NetApp FlexVol®, inline deduplication, inline compression, inline compaction, and thin provisioning
	Availability: High availability (HA) pair and multipath I/O
	Data protection: NetApp RAID DP®, NetApp RAID TEC®, and Snapshot technology
	SnapMirror Synchronous replication
	Performance acceleration: NetApp FlexCache® software
	Management: OnCommand Workflow Automation, ONTAP System Manager, and Active IQ Unified Manager
	Scalable NAS container: NetApp ONTAP FlexGroup
	Storage protocols supported: FC, FCoE, iSCSI, NFS, pNFS, and SMB
	NetApp SnapRestore® software: Restore entire Snapshot copies in seconds
	NetApp SnapMirror software: Simple, flexible backup and replication for disaster recovery
	NetApp FlexClone® technology: Instant virtual copies of files, LUNs, and volumes
	NetApp SnapCenter®: Unified, scalable platform and plug-in suite for application-consistent data protection and clone management
	NetApp SnapManager software: Application-consistent backup/recovery for enterprise applications
Extended-value software (optional)	NetApp OnCommand Insight: Flexible, efficient resource management for heterogeneous environments
	NetApp SnapLock®: Compliance software for write once, read many (WORM) protected data
	NetApp Volume Encryption (free license): Granular, volume-level, data-at-rest encryption
	NetApp FabricPool: Automatic data tiering to the cloud
	NetApp Data Availability Services: Cloud native backup solution for ONTAP storage

Datasheet

ONTAP 9
Data Management Software

Simplify your hybrid cloud. Unify your data.

Key Benefits

Smart: Simplify Operations and Reduce Costs

- Minimize capex and opex with leading storage efficiency.
- Provision storage in minutes for Oracle, SAP, Microsoft SQL, VMware, and other business apps.
- Tier your cold data to the cloud. Automatically.

Powerful: Respond to Changing Business Requirements

- Accelerate critical workloads with industry-leading performance.
- Scale capacity and performance without disruption.
- Deploy enterprise applications on NetApp storage systems, commodity servers, or in the cloud.

Trusted: Protect and Secure Your Data Across the Hybrid Cloud

- Guard against data loss and accelerate recovery with integrated data protection.
- Eliminate business disruptions due to failures, maintenance, and site disasters.
- Protect your sensitive company and customer information with built-in data security.

The Challenge

Businesses today are under pressure to become more efficient, respond quickly to new opportunities, and improve customer experience. During their digital transformation to address these challenges, they must modernize their IT infrastructure and integrate new types and uses of data into their existing environment. They also need to effectively manage and protect their data wherever it resides—on premises and in the cloud—while reducing costs, increasing security, and operating with existing IT staff.

The Solution

Create a storage infrastructure that is smart, powerful, and trusted. Simplify how you manage your data that is spread across your hybrid cloud environment. NetApp® ONTAP® 9, the industry's leading enterprise data management software, combines new levels of simplicity, flexibility, and security with powerful data management capabilities, proven storage efficiencies, and leading cloud integration.

With ONTAP 9, you can build an intelligent hybrid cloud that is the foundation of a NetApp Data Fabric that spans flash, disk, and cloud. Flexibly deploy storage on your choice of architectures—hardware storage systems, software-defined storage (SDS), and the cloud—while unifying data management across all of them. Accelerate your enterprise applications with flash, without compromising on the essential data services that you need. And seamlessly manage your data as it flows to wherever you need it most to help you make the best possible decisions for your organization.

Smart: Simplify Operations and Reduce Costs
Get proven storage efficiency

With ONTAP, you get a comprehensive, industry-leading portfolio of storage efficiency capabilities. Inline data compression, deduplication, and compaction work together to reduce your storage costs and maximize the data you can store. Plus, you can multiply your savings with space-efficient NetApp Snapshot™ copies, thin provisioning, replication, and cloning technologies.

Deploy workloads in less than 10 minutes

Built-in application workflows enable you to quickly and confidently provision storage for key workloads in less than 10 minutes—from power-on to serving data. These workloads include Oracle, SAP, SQL Server, and virtual desktops and servers. Years of NetApp experience and best practices are integrated into the System Manager wizard and factory configurations, enabling you to quickly set up your new configuration just by answering a few questions.

■ NetApp®

Simplify operations and unify data management

Whether you're adding new workloads or managing your existing environment, it's important to simplify your processes to maximize the productivity and responsiveness of your staff. ONTAP gives you a common set of features across deployment architectures, which simplifies administrative operations so that your IT team can focus on strategic business priorities. Unify data management across a hybrid cloud that can span flash, disk, and cloud running SAN and NAS workloads. Easily move your data within or between storage clusters, or to the cloud—wherever it is most useful. ONTAP is the foundation for a Data Fabric that gives you flexibility, choice, and control across your storage environment.

Tier automatically to cloud

Deliver high performance to your applications and reduce storage costs by automatically tiering cold data from the performance tier to a private or public cloud. FabricPool frees up space on your existing NetApp AFF infrastructure, so you can consolidate more workloads. For new all-flash purchases, FabricPool enables you to buy a smaller initial AFF configuration.

Maximize investment protection

ONTAP gives you the flexibility to create an integrated, scalable storage environment by clustering storage controllers from different families—AFF all-flash and FAS hybrid-flash systems—and from different generations. You can grow your system with the latest hardware, continue to use your older hardware, and connect all of it to the cloud. When it's time to retire a storage system, you can simply upgrade the controllers and keep data in place on the existing disk shelves.

Get simple, powerful management capabilities

NetApp data management infrastructure software is designed to manage hybrid clouds. You can centrally monitor the health of your environment by viewing metrics on capacity utilization, performance, availability, and data protection. It can also help automate your storage processes and integrate them into your data center orchestration platform for end-to-end service delivery for your private and hybrid cloud services.

In addition, NetApp Active IQ® intelligence provides predictive analytics and actionable insights based on machine learning and artificial intelligence applied to the vast data lake from the installed base of ONTAP systems. This intelligence helps you optimize your NetApp investment, simplify and automate operations, and achieve data center efficiencies.

Powerful: Respond to Changing Business Requirements

To support your critical applications, you need a storage environment that delivers high performance and availability. But you also need the versatility to scale and adapt as your business changes. ONTAP 9 delivers on all these requirements with flash performance for scalable, nondisruptive operations.

Get flash optimization

ONTAP 9 delivers the high throughput and low latency that enterprise applications require, while providing comprehensive data services. ONTAP 9 is optimized for flash, including AFF systems with NVMe solid-state drives (SSDs) and NVMe over Fabrics. AFF running the most recent versions of ONTAP provide up to twice the throughput of the same workloads compared to running on prior ONTAP releases, while still delivering consistent submillisecond latency.

ONTAP 9 running on NetApp FAS hybrid-flash systems improves the performance of HDD storage by automatically caching hot read data in flash. This provides a balance between performance and cost that is appropriate for many workloads.

Deliver consistent performance

To maintain high customer satisfaction, adaptive quality of service (QoS) helps you deliver consistent performance by automatically adjusting storage resource levels to respond to changes in workloads (number of terabytes of data, priority of the workload, and so on). Adaptive QoS simplifies the implementation of policies to keep your workloads within prescribed minimum and maximum throughput targets.

Stay ahead of business changes with seamless scalability

You can start small and grow with your business by using high-capacity SSDs or HDDs to scale your storage environment. Storage systems that run ONTAP can handle SAN and NAS workloads that range from a few terabytes up to 176PB. You can scale by adding capacity to existing storage controllers or scale out by adding controllers to seamlessly expand your cluster up to 24 nodes.

ONTAP also supports massive NAS data containers that are easy to manage. With NetApp ONTAP FlexGroup, a single namespace can grow to 20PB or 400 billion files while delivering consistent high performance and resiliency.

Future-proof your data infrastructure

ONTAP 9 lets you design and deploy your storage environment across the widest range of architectures, so you can match the approach that's right for your evolving business needs:

- On NetApp hardware systems: AFF all-flash systems and FAS hybrid-flash systems
- Within a converged infrastructure: FlexPod® converged infrastructure solution from NetApp and Cisco
- As software-defined storage on commodity servers: ONTAP Select
- Next to the cloud: NetApp Private Storage (NPS) for Cloud
- In the cloud: Cloud Volumes ONTAP

You can move your data seamlessly between architectures to place it in the optimal environment for performance, capacity, and cost efficiency.
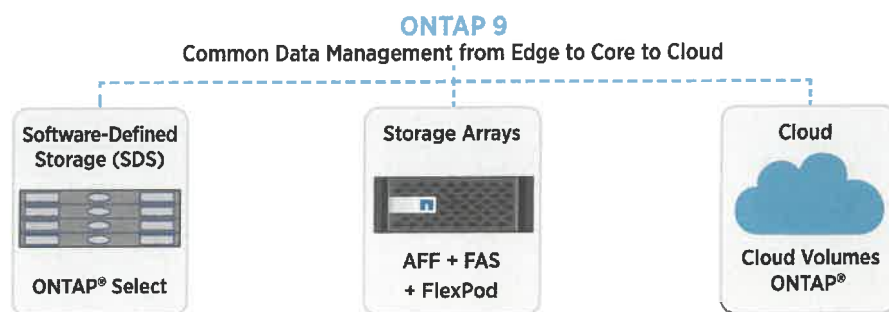
ONTAP 9
Common Data Management from Edge to Core to Cloud

Figure 1) Standardize data management across architectures with a rich set of enterprise data services.

Trusted: Protect and Secure Your Data Across the Hybrid Cloud
Integrated data protection and nondisruptive operations

ONTAP provides NetApp integrated data protection (IDP) to safeguard your operations and keep them running smoothly. Meet your requirements for local backup with nearly instantaneous recovery by using space-efficient Snapshot copies. Achieve remote backup/recovery and disaster recovery with NetApp SnapMirror® asynchronous replication. Get zero data loss protection (RPO=0) with SnapMirror Synchronous replication.

NetApp MetroCluster™ technology delivers business continuity by synchronously mirroring between locations for continuous data availability. A MetroCluster storage array, using FC or IP connectivity, can be deployed at a single site, across a metropolitan area, or in different cities.

With ONTAP, you can service and update your infrastructure during regular work hours without disrupting your business. Dynamically assign, promote, and retire storage resources without downtime over the lifecycle of an application. Data can be moved between controllers without application interruption, so you can get the data on the node that delivers the optimal combination of speed, latency, capacity, and cost.

Robust security

The leading portfolio of security capabilities in ONTAP helps you integrate data security across your hybrid cloud and avoid unauthorized data access. With the NetApp Volume Encryption feature that is built in to ONTAP, you can easily and efficiently protect your at-rest data by encrypting any volume on an AFF or FAS system. No special encrypting disks are required. In-flight encryption for backup and replication protects your data in transit. Plus, other features such as multifactor authentication, role-based access control (RBAC), and onboard and external key management increase the security of your data.

Secure consolidation

You can save time and money by sharing the same consolidated infrastructure for workloads or tenants that have different performance, capacity, and security requirements. And with ONTAP, you don't have to worry that the activity in one tenant partition will affect another. With multitenancy, a storage cluster can be subdivided into secure partitions that are governed by rights and permissions.

Rigorous compliance

To meet your stringent compliance and data retention policies, NetApp SnapLock® software enables write once, read many (WORM) protected data for your ONTAP environment. NetApp also provides superior integration with enterprise backup vendors and leading applications. Our IDP solutions also include integrated and unified disk-to-disk backup and disaster recovery in a single process for VMware and Microsoft virtualization. In addition, cryptographic shredding enables General Data Protection Regulation (GDPR) compliance.

Make a Simple, Straightforward Transition to ONTAP 9

No matter what your starting point is, NetApp streamlines your move to ONTAP 9:

- Upgrade from ONTAP 8.3 with a simple update of your ONTAP software—no disruption and zero downtime.
- Make a smooth transition from NetApp Data ONTAP operating in 7-Mode with proven tools and best practices, including the 7-Mode Transition Tool (7MTT) and copy-free transition (CFT).
- Use straightforward import processes from third-party storage to ONTAP 9.

Consult our experts to plan and implement your transition and gain the latest ONTAP advantages from day one. You can use NetApp Services or NetApp Services Certified Partners, you can do it yourself by using our proven tools and processes, or you can combine these approaches.

Plus, when you're running ONTAP, you can use the Managed Upgrade Service to get the most from your investment by ensuring that your ONTAP software is always up to date.

Make your move to ONTAP 9.

About NetApp

NetApp is the data authority for hybrid cloud. We provide a full range of hybrid cloud data services that simplify management of applications and data across cloud and on-premises environments to accelerate digital transformation. Together with our partners, we empower global organizations to unleash the full potential of their data to expand customer touchpoints, foster greater innovation and optimize their operations. For more information, visit www.netapp.com. #DataDriven

NetApp Software and Features

Table 1) ONTAP 9 offers a robust set of standard and optional features.

|	Function	Benefits
Data compaction	Packs more data into each storage block for greater data reduction	Works with compression to reduce the amount of storage that you need to purchase and operate
Data compression	Provides transparent inline and postprocess data compression for data reduction	Reduces the amount of storage that you need to purchase and maintain
Deduplication	Performs general-purpose deduplication for removal of redundant data	Reduces the amount of storage that you need to purchase and maintain
FabricPool	Automates data tiering to the cloud (public and private)	Decreases storage costs for cold data
Flash Pool™ Caching	Creates a mixed-media storage pool by using SSDs and HDDs	Increases the performance and efficiency of HDD pools with flash acceleration
FlexCache®	Caches actively read datasets within a cluster and at remote sites	Accelerates read performance for hot datasets by increasing data throughput within a cluster, and improves the speed and productivity of collaboration across multiple locations
FlexClone®	Instantaneously creates file, LUN, and volume clones without requiring additional storage	Saves you time in testing and development and increases your storage capacity
FlexGroup	Enables a single namespace to scale up to 20PB and 400 billion files	Supports compute-intensive workloads and data repositories that require a massive NAS container while maintaining consistent high performance and resiliency
FlexVol®	Creates flexibly sized volumes across a large pool of disks and one or more RAID groups	Enables storage systems to be used at maximum efficiency and reduces hardware investment
MetroCluster	Combines array-based clustering with synchronous mirroring to deliver continuous availability and zero data loss; up to 700km distance be-tween nodes	Maintains business continuity for critical enterprise applications and workloads if a data center disaster occurs
Performance capacity	Provides visibility of performance capacity that is available for deploying new workloads on storage nodes	Simplifies management and enables more effective provisioning of new workloads to the optimal node
QoS (adaptive)	Simplifies setup of QoS policies and automatically allocates storage resources to respond to workload changes (number of terabytes of data, priority of the workload, and so on)	Simplifies operations and maintains consistent workload performance within your prescribed minimum and maximum IOPS boundaries
RAID-TEC™ and RAID DP® technologies	Provides triple parity or double-parity RAID 6 implementation that prevents data loss when three or two drives fail	Protect your data without the performance impact of other RAID implementations; reduce risks during long rebuilds of large-capacity HDDs
SnapCenter®	Provides host-based data management of NetApp storage for databases and business applications	Offers application-aware backup and clone management; automates error-free data restores
SnapLock	Provides WORM file-level locking	Supports regulatory compliance and organizational data retention requirements
SnapMirror	Provides integrated remote backup/recovery and disaster recovery with incremental asynchronous data replication; preserves storage efficiency savings during and after data transfer	Provides flexibility and efficiency when replicating data to support remote backup/recovery, disaster recovery, and data distribution
SnapMirror Synchronous	Delivers incremental, volume-granular, synchronous data replication; preserves storage efficiency savings during and after data transfer	Achieve zero data loss protection (RPO=0)
SnapRestore®	Rapidly restores single files, directories, or entire LUNs and volumes from any Snapshot copy	Instantaneously recovers files, databases, and complete volumes from your point-in-time Snapshot copy
Snapshot	Makes incremental data-in-place, point-in-time copies of a LUN or a volume with minimal performance impact	Enables you to create frequent space-efficient backups with no disruption to data traffic
NetApp Volume Encryption	Provides data-at-rest encryption that is built into ON-TAP	Lets you easily and efficiently protect your at-rest data by encrypting any vol-ume on an AFF or FAS system; no special encrypting disks are required

ONTAP 9: Harness the Power of the Hybrid Cloud

NetApp ONTAP simplifies data management for any application, anywhere. Accelerate and protect data across the hybrid cloud; and future-proof your data infrastructure. The latest version, ONTAP 9.7, offers a number of enhancements, including a new management user interface and synchronous mirroring with MetroCluster.

The State of Est Virginias's transformation into a digital business brings with it pressures to be more efficient, respond quickly to new opportunities, and improve the customer experience. This might require modernizing your IT infrastructure, integrating new types and uses of data into your existing environment, and managing data on premises as well as in the cloud—yet operations must be simplified, costs reduced, and security increased.

NetApp® ONTAP 9® unifies data management across flash, disk, and cloud. It bridges current enterprise workloads and new emerging applications providing unmatched versatility, comprehensive data protection, and leading storage efficiency. NetApp ONTAP 9.7 is the latest generation of the leading data management software that delivers the performance, data resiliency, protection, and scalability that you need for your data infrastructure. ONTAP 9.7 continues to build the foundation for a modern data fabric. You can easily harness the power and agility of the hybrid cloud to get the most value from your data wherever you need it—at the edge, in the data center, or in the cloud. This latest release of ONTAP software is well suited for enterprise business applications and for artificial intelligence (AI) and real-time analytics.

Leverage ONTAP 9 to:

- Simplify operations and reduce cost
- Adapt to changing business needs
- Protect and secure data across the hybrid cloud
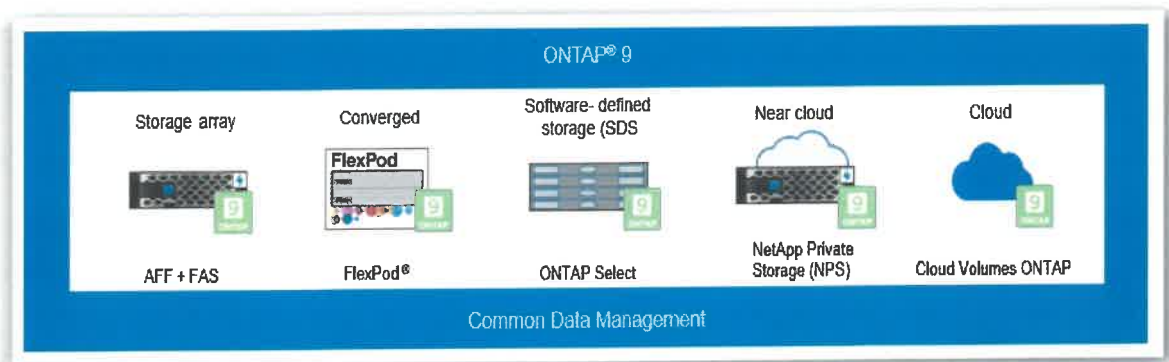
Figure 1: **Standardize data management across architectures with a rich set of enterprise data services.**

"Ease of use is the most valuable feature for us....With ONTAP we have more shelves, more disks, and aggregates."

— Peggy Baladera, Storage Tec, General Dynamics Mission Systems Inc.

Simplify Operations and Reduce Costs

Although storage might double in size, it no longer means there is twice as much work required. ONTAP has a common set of features across deployment architectures that simplify complex tasks so your staff can be more productive.

Receive Proven Storage Efficiency

With ONTAP, you can reduce costs with one of the most comprehensive storage efficiency offerings in the industry. You get NetApp Snapshot™ copies, thin provisioning, as well as replication and cloning technologies. You also get inline data compression, inline deduplication, and inline compaction that work together to reduce data management costs and maximize effective capacity. In addition, FabricPool automates the cost-efficient tiering of cold data to both public and private clouds.

Deploy Workloads in Less Than 10 Minutes

Fast provisioning workflows enable the deployment of key workloads such as Oracle, SQL Server, SAP HANA, VDI, and VMware in less than 10 minutes from power-on to serving data. Years of NetApp experience and best practices are integrated into the System Manager wizard and factory configurations, so you can quickly set up new configurations by answering a few questions. As new workloads are deployed, ONTAP 9 gives you the visibility to know which node has the most performance capacity available for optimal deployment.

Save Time with the New Management User Interface

ONTAP System Manager has been redesigned with new dashboard page views and simpler workflows that are based on REST APIs. The new management user interface gives you the ability to easily see the status of your cluster and to take quick actions to complete management tasks or mitigate risks before they become problems. ONTAP System Manager will save you time by showing key system information about capacity, hardware health, networking, and performance history with up to one year of data. Only one screen is needed for provisioning LUNs or NAS volumes.

Simplify Operations and Unify Data Management

Simplify your operations by unifying data management across a hybrid cloud that can span flash, disk, and cloud running SAN and NAS workloads. Increase the efficiency of your staff and easily move data between nodes to where it is most needed. ONTAP is the foundation for a data fabric that gives freedom, choice, and control across your storage environment.

Automatically Tier to Cloud

You can deliver high performance to your applications and reduce storage costs by automatically tiering cold data from the performance tier to a private or public cloud. FabricPool frees up space on your existing NetApp All Flash FAS (AFF) infrastructure, so you can consolidate more workloads.
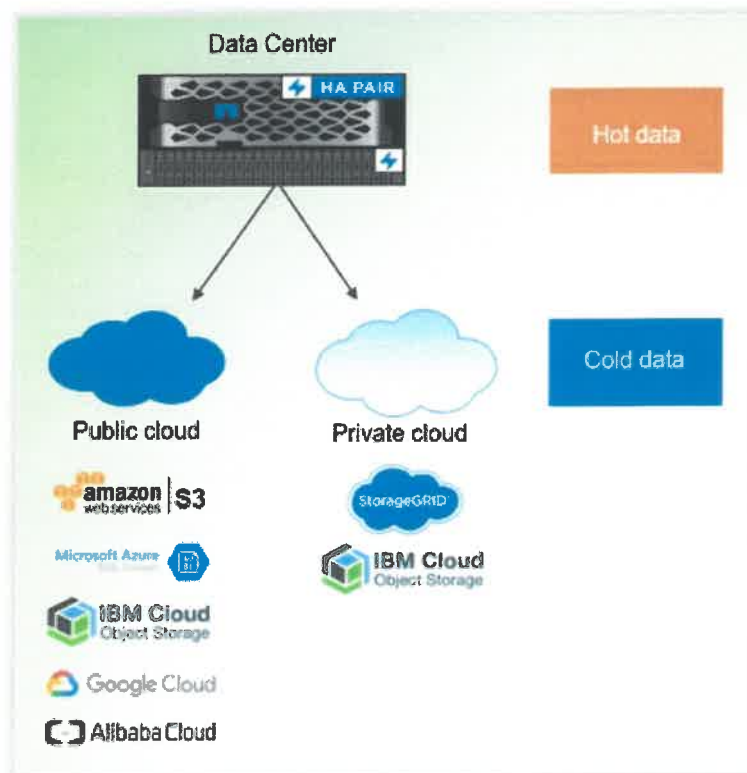
Figure 2: Automatic cloud tiering of cold data – *ONTAP 9.7 enables mirroring of tiered, cold data to multiple cloud buckets, either in public clouds or in on the premises. This feature increases your flexibility to change cloud-tiering providers or locations and gives you an additional level of resiliency if one cloud tier location goes offline.*

Maximize Investment Protection

ONTAP gives you the flexibility to create an integrated, scalable storage environment by clustering storage controllers from different families—AFF and FAS—as well as from different generations. Grow with the latest hardware and continue to use your older hardware. When it is time to retire a storage system, simply upgrade the controllers and keep data in place on the existing disk shelves.

Gain Simple, Powerful Management Capabilities

NetApp data management infrastructure software manages hybrid clouds. You can centrally monitor the health of your environment by viewing metrics on capacity utilization, performance, availability, and data protection. It can also help automate your storage processes and integrate them into your data center orchestration platform for end-to-end service delivery for your private and hybrid cloud services.

NetApp Active IQ® intelligence provides predictive analytics and actionable insights based on machine learning and artificial intelligence. This intelligence helps optimize your NetApp investment, simplify and automate operations, and achieve data center efficiencies.

> *"ONTAP has really reduced our costs because we learned that we could use our storage with fewer machines and drive down data center costs."*
>
> *— Oliver Fuckner, Systems Administrator, Strato AG*

Adapt to Changing Business Needs

To support your critical applications, you need a storage environment that cost-effectively delivers high performance and availability that can also scale with business growth and protect your valuable data. ONTAP 9 delivers on all these requirements with highly efficient flash performance for scalable, nondisruptive operations.

Optimized for Flash

ONTAP 9 delivers the horsepower that critical applications require without compromising on rich data services. AFF systems running ONTAP 9 are optimized specifically for flash, including AFF systems with NVMe solid-state drives (SSDs) and NVMe over Fabrics, providing up to twice the performance compared to the same workloads running on prior ONTAP releases, while still delivering consistent submillisecond latency.

ONTAP 9 also enables FAS hybrid-flash systems to deliver flash-accelerated performance that is balanced with hard disk drives (HDD) economies. Hot data is automatically cached in flash to accelerate application performance.

Consistent Performance

Quality of service (QoS) workload management allows you to control the resources that each workload can consume, to better manage performance spikes and improve customer satisfaction. Adaptive QoS can be used to set both maximum and minimum resource levels, which is especially important for business-critical workloads, and it automatically adjusts storage resource levels to respond to changes in workloads and deliver consistent performance.

Seamless Scalability

Storage systems that run ONTAP can transparently scale from a few terabytes up to 176PB. You can scale up by adding capacity. Or scale out by adding additional storage controllers to seamlessly expand your cluster up to 24 nodes as your business needs grow. Rebalance capacity to improve service levels by redeploying workloads dynamically and avoiding hot spots. You can also isolate workloads and offer levels of service by using different controller technologies, storage tiers, and QoS policies.

In addition, ONTAP supports massive NAS containers that are easy to manage. With FlexGroup, a single namespace can grow to 20PB and 400 billion files while maintaining consistent high performance and resiliency.

Future-proof Your Data Infrastructure

ONTAP 9 provides the flexibility you need to design and deploy your storage environment across the widest range of architectures, so you can match the approach that is best for your evolving business needs:

- NetApp hardware systems: AFF all flash systems and FAS hybrid-flash systems
- Converged infrastructure: FlexPod®
- On commodity servers as software-defined storage (SDS): ONTAP Select
- Next to the cloud: NetApp Private Storage (NPS) for Cloud
- In the cloud: Cloud Volumes ONTAP
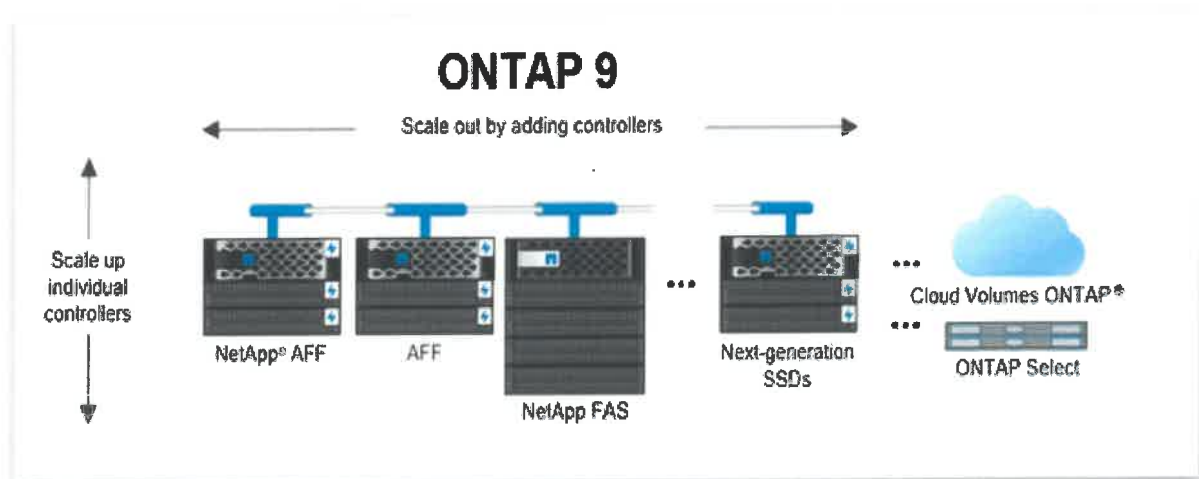
Figure 3: Scale seamlessly – *Scale out by intermixing your choice of flash and hybrid-flash nodes, upgrade hardware/software or scale up without disrupting users, incorporate software-defined, cloud, and future-generation flash.*

Flexibly consolidate both NAS and SAN workloads onto any ONTAP environment while delivering consistent data services. You can also seamlessly move your data between architectures to get your data onto the optimal environment for performance, capacity, and cost efficiency.

Protect and Secure Your Data Across the Hybrid Cloud

ONTAP provides comprehensive data protection so you can protect your data seamlessly across the hybrid cloud.

Integrated Data Protection and Nondisruptive Operations

NetApp offers a complete suite of Integrated Data Protection (IDP) to safeguard your operations and keep them running smoothly. You can:

- Meet your requirements for local backup with near-instant recovery by using space-efficient NetApp Snapshot copies. Application-created Snapshots that are used by third-party data protection software are replicated, as well as LUN clones.

- Achieve remote backup/recovery and disaster recovery with SnapMirror® asynchronous replication.

- Get zero data loss protection (RPO=0) for your NVMe environment with SnapMirror Synchronous replication.

NetApp MetroCluster™ technology delivers business continuity by synchronously mirroring between locations for continuous data availability. A MetroCluster storage array, leveraging FC or IP connectivity, can be deployed at a single site, across a metropolitan area, or in different cities. With the release of ONTAP 9.7, you can use your existing network infrastructure for synchronous mirroring with MetroCluster. Simultaneously mirror your tiered data out to multiple clouds. You get the flexibility to store your data at multiple cloud providers for added resiliency and it simplifies the process for changing cloud providers.

ONTAP gives you the ability to perform critical tasks without interrupting your business by dynamically assigning, promoting, and retiring storage resources without downtime over the lifecycle of an application. Data can be moved between controllers without application interruption, so you can get the data on the node that delivers the optimal combination of speed, latency, capacity, and cost.
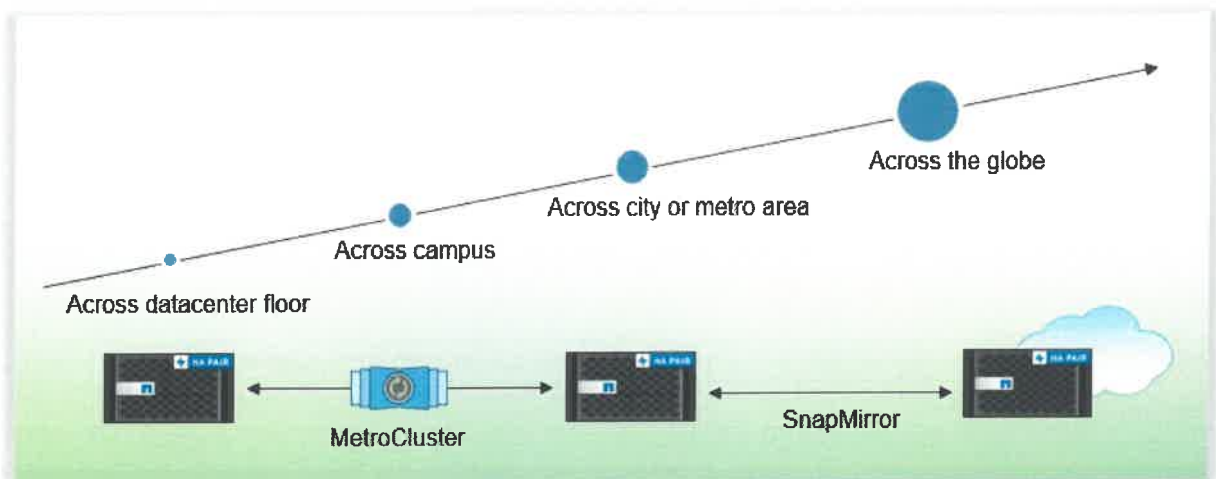
Figure 4:   SnapMirror extends data protection across the globe.

"Since implementing NetApp® MetroCluster™ in 2009, Jack Wolfskin hasn't experienced a single second of downtime or any data loss. Another advantage of MetroCluster software is that we manage upgrades from anywhere instead of coming in on the weekends."

— Severin Canisius, Senior IT Manager

Robust Security

Security capabilities in ONTAP help you integrate data security across your hybrid cloud and avoid unauthorized data access. You can easily and efficiently protect at-rest data by encrypting any volume on an AFF or FAS system with NetApp Volume Encryption—a feature that is built in to ONTAP. It does not require special encrypting disks. In-flight encryption for backup and replication protects data in transit. Plus, other features such as multifactor authentication (MFA), role-based access control (RBAC), and onboard and external key management increase the security of your data. With ONTAP 9.7, it is simpler to protect your data by automatically enabling data at-rest encryption for new volumes when an encryption key manager is configured on the cluster. Included with ONTAP 9.7, Active IQ Unified Manager now provides a security dashboard that highlights where you can improve cluster-wide security based on best practices.

Secure Consolidation

ONTAP gives you the ability to save time and money by sharing the same consolidated infrastructure for workloads or tenants that have different performance, capacity, and security requirements without fear that the activity in one tenant partition will affect another. With multitenancy, a storage cluster can be subdivided into secure partitions governed by rights and permissions.

Rigorous Compliance

To meet stringent compliance and data retention policies, NetApp SnapLock® software enables write once, ready many (WORM) protected data for your ONTAP environment. NetApp also provides superior integration with enterprise backup vendors and leading applications. Our IDP solutions include integrated and unified disk-to-disk backup and disaster recovery in a single process for VMware and Microsoft virtualization. In addition, cryptographic shredding enables General Data Protection Regulation (GDPR) compliance.

> *"The secure multitenancy built into ONTAP is key to our cloud business model."*
>
> — *Frank Bounds, Senior Storage Engineer, TCDI*

Simple, Straightforward Transition to ONTAP 9

No matter what your starting point, NetApp streamlines your move to ONTAP 9. You can:

- Upgrade from ONTAP 8.3 with a simple update of your ONTAP software—no disruption and zero downtime.

- Make a smooth transition from ONTAP 7-Mode with proven tools and best practices, including 7-Mode Transition Tool (7MTT) and Copy Free Transition (CFT).

- Use straightforward import processes from third-party storage to ONTAP 9.

Consult our experts to plan and implement your transition and gain the latest ONTAP advantages from day one. You can use either NetApp Services or NetApp Certified Services Partners, do it yourself using our proven tools and processes, or choose a combination of approaches.

> *"Using the brand-new copy-free transition process to achieve both the hardware refresh and upgrade to ONTAP with minimal business disruption was the perfect option. It reduced risk, slashed migration time, and cut costs and was something we were able to fully justify."*
>
> — *Andrew Bentley, Infrastructure Lead, Repsol Sinopec Resources UK*

ONTAP Technical Highlights

The building blocks for ONTAP scale-out storage configurations are high-availability (HA) pairs in which two storage controllers are interconnected to the same set of disks. If one controller fails, the other takes over its storage and continues serving data.

With ONTAP, each storage controller is referred to as a cluster node. Nodes can be different models and sizes of AFF and FAS systems. Disks are made into aggregates, which are groups of disks of a type that are composed of one or more RAID groups protected by using NetApp RAID DP® and RAID TEC technology.

A key differentiator in an ONTAP environment is that numerous HA pairs are combined into a cluster to form a shared pool of physical resources that are available to applications, SAN hosts, and NAS clients. The shared pool appears as a single system image for management purposes. This means that there is a single common point of management, whether through the graphical user interface or command-line interface tools, for the entire cluster.

Although the members of each HA pair must be the same controller type, the cluster can consist of heterogeneous HA pairs of AFF all-flash arrays as well as FAS hybrid-flash arrays. Over time, as the cluster grows, and new controllers are released, it is likely to evolve into a combination of several different node types. All cluster capabilities are supported, regardless of the underlying controllers in the cluster.

To improve data access in NAS applications, NetApp virtualizes storage at the file-system level. This enables all client nodes to mount a single file system, access all stored data, and automatically accommodate physical storage changes that are fully transparent to the clients. Each client or server can access a huge pool of data residing across the ONTAP system through a single mount point.

Meet High-Availability Requirements

The proven reliability features in NetApp hardware and software result in data availability of more than 99.9999% as measured across the NetApp installed base. Backup and replication technologies integrated in the NetApp ONTAP data management software help keep your applications and data continuously available to users.

Nondisruptive Operations to Eliminate Downtime

Nondisruptive operations (NDO) are fundamental to the superior scale-out architecture of NetApp ONTAP. NDO is achieved as the storage infrastructure remains up and serving data throughout the execution of hardware and software maintenance operations as well as during other IT lifecycle operations. The goal of NDO is to eliminate downtime—whether it is preventable, planned, or unplanned—and to allow changes to your systems to occur at any time.

ONTAP allows you to transparently move data and network connections anywhere within the storage cluster. The capability to move individual data volumes or LUNs allows you to redistribute across a cluster at any time and for any reason. It's transparent and nondisruptive to NAS and SAN hosts, and it enables the storage infrastructure to continue to serve data throughout these changes. This is helpful to rebalance capacity usage, to optimize for changing performance requirements, or to isolate one or more controllers or storage components when it becomes necessary to execute maintenance or lifecycle operations.

Table 1:   Hardware and software maintenance operations can be performed nondisruptively with ONTAP.

| Operation	Details
Upgrade software	Upgrade from one version of ONTAP to another
Upgrade firmware	System, disk, switch firmware upgrade
Replace failed controller or component within a controller	Network interface cards (NICs), host bus adapters (HBAs), and power supplies
Replace failed storage components	Cables, drives, shelves, and I/O modules

Table 2:   Lifecycle operations can be performed nondisruptively with ONTAP.

Operation	Details
Scale storage	Add storage (shelves or controllers) to a cluster and redistribute volumes for future growth
Scale hardware	Add hardware to controllers to increase scalability, performance, or capability (HBAs, NICs, NetApp Flash Cache™ or Flash Pool™ caching)
Refresh technology	Upgrade storage shelves, storage controllers, back-end switch
Rebalance controller performance and storage utilization	Redistribute data across controllers to improve performance
Rebalance capacity	Redistribute data across controllers to account for future capacity growth
Rebalance disk performance and utilization	Redistribute data across storage tiers within a cluster to optimize disk performance

On-Demand Scalability—Expand as you Build

The ONTAP architecture is key to delivering maximum on-demand scalability for your shared IT infrastructure, offering performance, price, and capacity options.
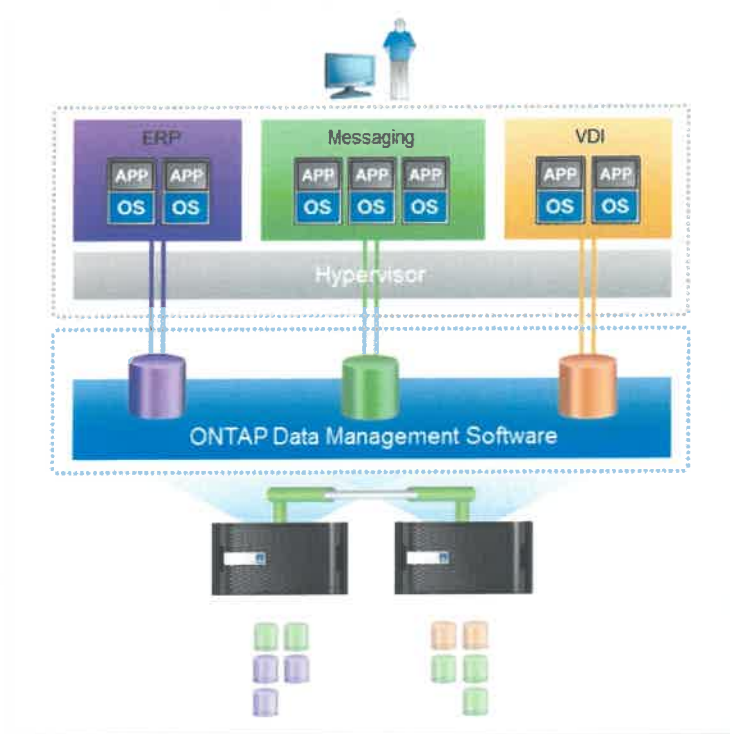
Figure 5:   Expand as you build – *Start with a two-node cluster and expand controllers and capacity when you need to, nondisruptively.*

There are several approaches for leveraging flash in NetApp FAS hybrid-flash systems to accelerate workloads and reduce latency. Flash Cache can increase read performance for frequently accessed data. Plus, Flash Pool aggregates combine SSDs with traditional hard drives for delivering optimal performance and efficiency.

NetApp AFF all-flash systems offer the advantage of scalable performance with consistent low latency for SAN and NAS workloads. Customers can start with deploying AFF in an HA pair configuration to deliver enterprise-grade data management and high performance for a dedicated workload. If additional performance is required, AFF can scale out in a cluster—up to 24 nodes, delivering millions of IOPS at submillisecond latency and a total of over 88PB of SSD capacity.

The extra value of AFF shines when it is used as a high-performance node combined with hybrid-flash FAS systems in an ONTAP environment. This becomes a single storage repository for all workloads. And it enables nondisruptive movement of workloads to the node that best meets your performance and price/performance requirements at different points in time.

Multiprotocol Unified Architecture

A multiprotocol unified architecture provides the capability to support several data access protocols concurrently in the same overall storage system across a range of controller and disk storage types. ONTAP protocol support includes:

- SMB 1, 2, 2.1, 3, 3.1.1 (CIFS)
- NFS v3, v4, and v4.1, including pNFS
- iSCSI
- FCP (Fibre Channel Protocol)
- FCoE (Fibre Channel over Ethernet)
- NVMe over FC (NVMe/FC), starting with ONTAP 9.4

Data replication and storage efficiency features in ONTAP are seamlessly supported across all protocols.

SAN Data Services

With the supported SAN protocols (FC, FCoE, iSCSI, and NVMe/FC), ONTAP provides LUN services. This is the capability to create LUNs and make them available to attached hosts. Because the cluster consists of numerous controllers, there are several logical paths to any individual LUN. A best practice is to configure at least one path per node in the cluster. Asymmetric Logical Unit Access is used on the hosts so that the optimized path to a LUN is selected and made active for data transfer. Support for multipath I/O is also available from leading OS and third-party driver vendors.

NAS Data Services

ONTAP can provide a single namespace with the supported NAS protocols such as SMB [CIFS] and NFS (NAS clients can access a very large data container by using a single NFS mount point or CIFS share). Each client, therefore, needs only to mount a single NFS file system mount point or access a single CIFS share, requiring only the standard NFS and CIFS client code for each operating system.

The namespace of ONTAP is composed of potentially thousands of volumes joined by the cluster administrator. To the NAS clients, each volume appears as a folder or subdirectory,

nested off the root of the NFS file system mount point or CIFS share. Volumes can be added at any time and are immediately available to the clients, with no remount required for visibility to the new storage.

The clients have no awareness that they are crossing volume boundaries as they move about in the file system, because the underlying structure is completely transparent.

ONTAP can be architected to provide a single namespace, yet it also supports the concept of several securely partitioned namespaces, called Storage Virtual Machines or SVMs. This accommodates the requirement for multi-tenancy or isolation of particular sets of clients or applications.

Opex and Capex Efficiency—Grow Your Business, Not IT Expense

NetApp storage solutions operating with ONTAP 9 deliver the industry's leading storage efficiency capabilities with features such as inline compression, inline deduplication, inline data compaction, thin provisioning, and thin clones. With these features coupled with space-efficient NetApp Snapshot copies, RAID DP, and RAID TEC, you can enjoy significant reductions in required disk capacity (varies by workload) when compared with traditional storage technologies.

Table 3:   ONTAP 9 offers a robust set of standard and optional features.

NetApp Software and Features		
	Function	**Benefits**
Data compaction	Packs more data into each storage block for greater data reduction.	Works with compression to reduce the amount of storage that you need to purchase and operate.
Data compression	Provides transparent inline and postprocess data compression for data reduction.	Reduces the amount of storage that you need to purchase and maintain.
Deduplication	Performs general-purpose deduplication for removal of redundant data.	Reduces the amount of storage that you need to purchase and maintain.
FabricPool	Automates data tiering to the cloud (public and private).	Decreases storage costs for cold data.
Flash Pool™ Caching	Creates a mixed-media storage pool by using SSDs and HDDs.	Increases the performance and efficiency of HDD pools with flash acceleration.
FlexCache®	Caches datasets within a cluster and at remote sites.	Accelerates read performance for hot datasets by increasing data throughput within a cluster and improves the speed and productivity of collaboration across multiple locations. FlexGroup volumes can now be cached with FlexCache, enabling data volumes larger than 100TB to be cached.

NetApp Software and Features

	Function	Benefits
FlexClone®	Instantaneously creates file, LUN, and volume clones without requiring additional storage.	Saves you time in testing and development and increases your storage capacity.
FlexGroup	Enables a single namespace to scale up to 20PB and 400 billion files.	Supports compute-intensive workloads and data repositories that require a massive NAS container while maintaining consistent high performance and resiliency. For enhanced security and locking, NFSv4.0 and NFSv4.1 are now supported.
FlexVol®	Creates flexibly sized volumes across a large pool of disks and one or more RAID groups.	Enables storage systems to be used at maximum efficiency and reduces hardware investment. To enable higher performance and to scale capacity, you can now convert a FlexVol volume to a single-member FlexGroup volume without copying data.
MetroCluster	Combines array-based clustering with synchronous mirroring to deliver continuous availability and zero data loss; up to 700km distance between nodes.	Maintains business continuity for critical enterprise applications and workloads if a data center disaster occurs.
Performance capacity	Provides visibility of performance capacity that is available for deploying new workloads on storage nodes.	Simplifies management and enables more effective provisioning of new workloads to the optimal node.
QoS (adaptive)	Simplifies setup of QoS policies and automatically adjusts storage resources to respond to work-load changes (number of TB of data, priority of the workload, etc.).	Simplifies operations and maintains consistent workload performance within your prescribed minimum and maximum IOPS boundaries.
RAID-TEC™ and RAID DP® technologies	Provides triple parity or double-parity RAID 6 implementation that prevents data loss when three or two drives fail.	Protect your data without the performance impact of other RAID implementations; reduce risks during long rebuilds of large-capacity HDDs.
SnapCenter®	Provides host-based data management of NetApp storage for databases and business applications.	Offers application-aware backup and clone management; automates error-free data restores.

NetApp Software and Features

	Function	Benefits
SnapLock	Provides WORM file-level locking.	Supports regulatory compliance and organizational data retention requirements.
SnapMirror	Provides integrated remote backup/recovery and disaster recovery with incremental asynchronous data replication; preserves storage efficiency savings during and after data transfer.	Provides flexibility and efficiency when replicating data to support remote backup/recovery, disaster recovery, and data distribution.
SnapMirror Synchronous	Delivers incremental, volume-granular, synchronous data replication; preserves storage efficiency savings during and after data transfer.	Achieve zero data loss protection (RPO=0).
SnapRestore®	Rapidly restores single files, directories, or entire LUNs and volumes from any Snapshot copy.	Instantaneously recovers files, databases, and complete volumes from your point-in-time Snapshot copy.
Snapshot	Makes incremental data-in-place, point-in-time copies of a LUN or a volume with minimal performance impact.	Enables you to create frequent space-efficient backups with no disruption to data traffic.
Volume encryption	Provides data-at-rest encryption that is built into ONTAP.	Easily and efficiently protect your at-rest data by encrypting any volume on an AFF or FAS system; no special encrypting disks are required.

BRIEF

Deliver Private Cloud at Scale with NetApp HCI

■ **NetApp**®

Private Cloud Requires a Modern Approach to Infrastructure

In today's digital workplace, IT teams are being tasked to deliver more, and to deliver it faster. New applications and data are needed across multiple platforms. A recent survey of 650 IT decision makers across the globe found that increasing IT operational efficiency was the number one digital transformation goal, followed closely by improving the customer experience. Modernizing legacy infrastructure was cited as the most important initiative to achieve those goals.

Legacy infrastructure with separate silos for each application adds friction to cross-functional workflows and prevents data from being shared easily across teams. A new platform is needed to deliver the results necessary to drive digital workflows. This platform must scale with ease, deliver predictable performance to each workload, and take advantage of advanced automation to eliminate manual tasks.

Many enterprises once thought that public cloud was the solution to these challenges. However, IT teams quickly learned that despite agility and easy consumption, public cloud is not the answer for every workload. Enterprise IT teams today are striking a smarter balance between on-premises workloads— running on a private cloud—and workloads in the public cloud. The success of this hybrid cloud approach requires a private cloud that can deliver agility and self-service—and full control over performance and availability—while reducing costs versus public cloud.

The key decision that many IT teams are faced with is what infrastructure to choose to facilitate modernization and private cloud initiatives. Different stakeholders (see Figure 1) have specific requirements that must be addressed. CIOs are interested in driving digital transformation and adopting new consumption models to control cost. Application teams want a solution that helps them meet new business demands, ensures performance, and protects availability. Storage teams must respond more rapidly to growing data demands, even while budgets and staff are flat or shrinking.

Figure 1) Different stakeholders within your IT organization all have requirements that your private cloud must satisfy.

Enterprise IT teams are increasingly turning to hyper converged infrastructure (HCI) as a means to modernize legacy infrastructure, address the needs of diverse stakeholders, and enable private cloud. But, not every HCI architecture is the same. Only NetApp® HCI delivers the scalability, guaranteed performance, easy automation, and cloud connectivity needed to power your private cloud at scale, meeting your needs now and in the future.

NetApp HCI Simplifies Private Cloud at Scale
Eliminate the barriers to private cloud success

There are a variety of factors that can hamper the success of a private cloud.

- **Difficulty scaling.** Traditional infrastructure solutions can be difficult and time consuming to scale in the face of dynamic business demands, while many HCI solutions scale inefficiently and have narrow effective scaling limits.

- **Performance issues.** With a private cloud, you consolidate diverse workloads on the same infrastructure, and you may not always know what those workloads are or how they are changing day to day. Tenant workloads must not negatively impact the performance of other adjacent workloads and decrease user satisfaction.

- **Complex automation.** Traditional infrastructure can require complex and often fragile automation. With many infrastructure solutions—both traditional and hyperconverged—automation has been bolted on as an afterthought, limiting effectiveness. Deep automation allows IT teams to respond to user requirements much more efficiently.

- **Lack of cloud connectivity.** Your data centers are now part of a larger hybrid cloud environment. Success increasingly depends on being able to connect all elements together, but many solutions lack the services to allow your private cloud to become part of an integrated hybrid cloud solution.

NetApp HCI is an enterprise-scale hyper converged infrastructure solution designed to address these challenges and simplify and accelerate private cloud at scale. NetApp HCI (See Figure 2) integrates flexible compute options and proven all-flash storage in a turnkey scale-out solution that's simple to manage and easy to automate. This approach enables your private cloud environment to expand with no disruptions and no costly surprises.
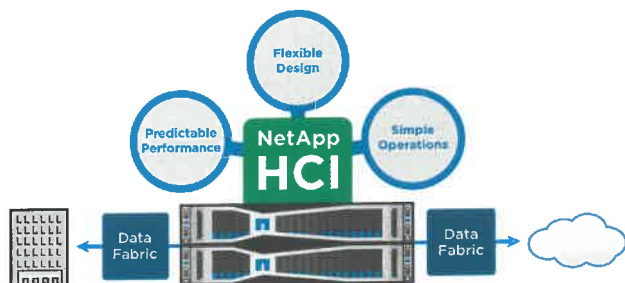

Figure 2) NetApp HCI combines a flexible, scalable design with predictable performance, automated operations, and superior cloud integration.

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NetApp HCI addresses both the business and technical challenges of Private Cloud with an innovative platform that is scalable, predictable, automated, and integrated.

Scale on Your Terms Without Disruption
Take the pain out of scaling private cloud infrastructure

NetApp HCI simplifies private cloud deployment with an agile, scale-out architecture that future-proofs your investments. Start small and grow as needed without disruption to operations or users. NetApp HCI eliminates painful migrations and forklift upgrades. You can integrate newer node technology with your existing cluster, so you never have to wait three years for an upgrade.

Because your business needs are constantly evolving, you can't expect a private cloud that scales compute and storage resources in lockstep to meet your needs. Each application has different resource requirements, and workloads come and go, making it difficult to accurately predict future resource needs.

NetApp HCI provides independent scaling of compute and storage, allowing you to dynamically scale on demand, while avoiding costly and inefficient over-provisioning and simplifying capacity and performance planning. By scaling compute and storage independently, NetApp HCI avoids the inefficiencies of HCI solutions with tightly coupled compute and storage. If compute is the limiting factor, with NetApp HCI you can simply add more compute nodes. If you need more storage capacity or I/O performance, simply add storage nodes. New storage nodes integrate seamlessly, so there's never any need to rip and replace the infrastructure that's already in place to scale your environment. You're never forced to add compute resources when you need storage or vice versa, and planned downtime is a thing of the past.
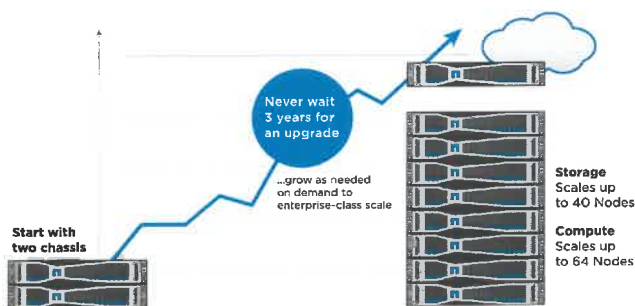
Figure 3) NetApp HCI scales compute and storage independently allowing you to grow resources to match needs without over-provisioning or purchasing resources you don't need.

An elastic design allows you to dynamically scale resources up or down independently for cloud-like agility. Each new node delivers a precise amount of compute performance—or storage performance and capacity—for predictable resource scaling. Application placement is automatically load-balanced in the background.

A unique open and flexible architecture enables you to preserve existing infrastructure investments, lowering total cost of ownership. Leverage existing virtualization infrastructure, licenses, and compute in conjunction with NetApp HCI to lower initial acquisition costs while integrating with existing platforms and operations.

Predictable Performance Delivery
Guarantee performance for every private cloud workload

In a private cloud, you often have less insight into the nature of running workloads. Your marketing or sales team may decide to run I/O-intensive analytics, or a DevOps team may kickoff a demanding software build touching thousands of files. With traditional approaches to storage infrastructure and previous approaches to HCI, this unpredictability leads to inevitable slowdowns and user complaints. With those solutions, the only option is often to over-provision resources, moving back in the direction of the inefficient, siloed environment you were trying to escape. Some enterprises have become somewhat disillusioned with private cloud for exactly these reasons.

NetApp HCI eliminates these problems by preventing workloads from interfering with each other. All applications are able to deliver predictable performance, even in the face of big spikes in activity, increasing productivity and eliminating complaints. The unique architecture of NetApp HCI prevents spikes in activity and runaway processes from interfering with other workloads running in the same cluster. NetApp HCI manages performance automatically and gives you the tools to address performance issues instantaneously.

Figure 4) With NetApp HCI you can mix diverse workloads in a single private cloud. Databases, traditional enterprise applications, containers and more can share the same infrastructure without interfering with one another.

With NetApp HCI you can:

- **Deliver predictable storage performance for each application.** With traditional storage infrastructure, the penalty for getting capacity and performance allocations wrong is complicated and time-consuming data migration or even re-architecting. NetApp HCI is ideal for private cloud environments because you can allocate capacity and performance independently for every workload and application and easily adjust allocations.

- **Automate data distribution and load balancing.** To guarantee performance, NetApp HCI balances pools of performance and capacity across the HCI cluster. Resources are provisioned to meet the needs of each volume or virtual

disk with performance defined in terms of minimum, maximum, and burst characteristics. Changes to these performance and capacity policies take effect immediately without the need to move data to different storage.

- **Confidently mix workloads.** A single private cloud platform can support a mix of workload including databases, virtual desktops, and cloud-native apps. Every application gets the performance it needs with no impact to other applications.

- **Provision storage the same way you provision virtual compute resources.** Storage resources are allocated to each individual volume, virtual volume, or virtual disk from available capacity and IOPS with no storage expertise required.

- **Address performance problems instantly.** NetApp HCI eliminates the penalty for underestimating performance requirements. You simply modify quality-of-service policies to change the settings for minimum, maximum, and burst, and the new settings take effect immediately. No storage vMotion or physical data movement is needed to change performance levels.

- **Minimize the impact of failures:** Availability is critical to private cloud. NetApp HCI can absorb multiple concurrent faults without affecting application performance. Recovering from a drive or node failure takes only minutes and is fully automatic, requiring no operator intervention and eliminating the fire drills that typically occur when a component fails.

These capabilities are essential for a private cloud operating at scale.

Complete System Automation
Meet diverse business needs with simple, fast automation

Automation may be the Achilles' heel for most infrastructure solutions for private cloud. For many solutions, automation was bolted on after the fact, and—because the platforms themselves are complex to design, install, operate, and scale—automation to create unique workflows and services is complicated.

To deliver on the self-service needs of cloud users, common provisioning and management tasks need to be automated so they can be performed without your IT team having to get involved. Automating tasks and allowing users to initiate them directly, is essential for delivering a public-cloud experience from your private cloud.

NetApp HCI greatly simplifies infrastructure and storage management. No storage knowledge is required, and you can provision storage with workflows that are as simple as those for provisioning a VM. You just select the initial capacity and IOPS for each volume.

Because NetApp HCI is simple to provision and manage, it's easy to automate customized storage provisioning as part of a self-service portal. Users can provision and modify storage to address their workload needs without having to understand

the complexities of LUNs, storage tiers, and so on. If they get the allocation wrong initially, they can modify capacity and performance instantly by changing the settings.

NetApp HCI was designed from the ground up to be 100% programmable, so you can rapidly deploy applications and services that incorporate HCI functions to address business needs. With comprehensive, well-documented APIs and deep integration with management and orchestration platforms, NetApp HCI interoperates with everything in your environment. (See Figure 2.) You can use the automation tools you prefer, including tools you already use in production, and simplify management as your private cloud grows.
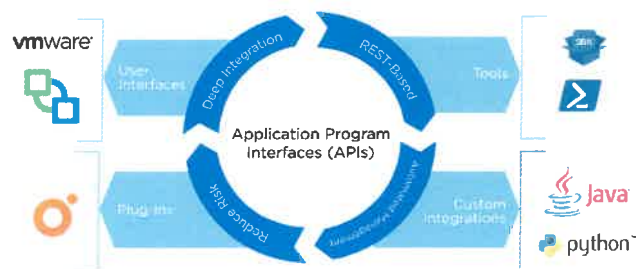

Figure 5) NetApp HCI was designed from the ground up to provide compatibility and programmability.

To simplify ongoing management tasks, you can manage NetApp HCI entirely from the installed VMware vSphere web client, including monitoring and changing quality of service (QoS) settings for performance. After initial configuration, there's no need to touch the NetApp HCI user interface to control storage. You can manage everything through the VMware vSphere interface.

The VMware Storage Policy Based Management (SPBM) model allows storage resources to be provisioned to meet specific application requirements. Storage services can be dynamically created, delivered, and managed based on policies that align a VM or virtual disk to storage capabilities. You modify the storage capabilities for a VM by changing the associated storage policy.

To deliver workflow automation, NetApp HCI is fully compatible with vRealize Orchestrator, allowing you to quickly and easily design and deploy scalable custom workflows from an intuitive graphical interface. The entire Element OS API has been integrated with Orchestrator as scriptable vRealize actions, allowing you to create custom workflows that utilize the full power of NetApp HCI.

In addition, NetApp HCI provides easy integration with the other automation tools such as PowerShell, Puppet, and Ansible that your teams may already be using, providing better control for large-scale environments. These integrations allow you to support agile development practices and DevOps needs. An API with over 200 methods allows for complete and direct control of the NetApp HCI platform, integrating directly with code or with

any tool you are using. You can drive software-defined storage management from any codebase including Java, Python, and .NET.

Data Fabric Integration
Connect with everything in your hybrid cloud environment

A private cloud environment needs to integrate easily with other IT operations, both on premises and in the cloud. Otherwise, it becomes another infrastructure silo, making your overall environment more complex. You must be able to manage and protect data globally and integrate with other important applications and services in your data centers and beyond.

NetApp HCI increases the agility of your end users and your business by delivering predictable performance and simplified operations on a highly flexible and efficient cloud architecture. Because NetApp HCI is Data Fabric ready out of the box, you can easily gain access to all your data across any cloud: public, private, or hybrid. By making data more accessible both on premises and in the cloud, the Data Fabric enables you to respond and innovate more quickly.

Integration with the Data Fabric allows NetApp HCI to provide a variety of advanced data services as part of your private cloud, including file services using ONTAP® Select, object services using StorageGRID®, replication services using SnapMirror®, data visibility using OnCommand® Insight, and backup and recovery services using AltaVault™. (See Figure 6.) These services increase the power and flexibility of your private cloud.
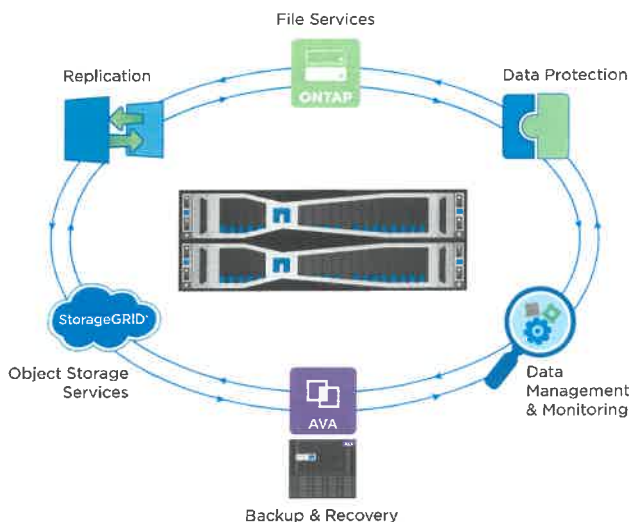
Figure 6) NetApp HCI provides full Data Fabric integration, providing advanced data services to your private cloud and full connectivity to other data center and cloud environments.

Through Data Fabric integration, your private cloud also has direct access to a range of NetApp Cloud Data Services, enabling data protection and other important workflows.

HCI at Enterprise Scale

A smarter approach to HCI, a better infrastructure solution for private cloud

No matter where you are on your cloud journey, NetApp can help you succeed. NetApp HCI delivers benefits for private cloud that traditional infrastructure solutions and other HCI solutions can't match. You can scale easily without artificial limitations, adding compute and storage independently, so you increase only the resources you need. You can confidently consolidate mixed workloads—including end-user computing, demanding databases, and cloud-native applications—on the same infrastructure with guaranteed performance. Advanced automation capabilities enable you to build out the self-service consumption that users demand from a private cloud.

NetApp HCI is an enterprise-scale hyper converged infrastructure solution that delivers predictable performance on a highly flexible, efficient architecture that is simple to deploy and manage. NetApp HCI allows you to meet rapidly changing IT needs so that you can focus on what matters most: growing your business.

Learn More
If you're ready to build a private cloud that operates at scale, NetApp is ready to help you. To learn more about NetApp HCI, visit:

- NetApp HCI 360° Demo
- A Hyper Converged Future for Digital Transformation
- Gartner Report: Competitive Landscape for Hyperconverged Integrated System

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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WP-0000

Scaling Performance for Enterprise HCI Environments

Author: Russ Fellows

August 2019

NetApp®

Evaluator Group

Executive Summary

Hyperconverged Infrastructure (HCI) has quickly gained adoption in many IT environments due to its relative simplicity and the ability to efficiently scale the number of applications for private cloud and virtual environments. As HCI systems have matured, IT administrators and application owners have grown comfortable with their capabilities, particularly the ability to quickly scale their deployments while maintaining efficiency through the use of a consistent set of integrated management tools.

According to the latest Evaluator Group research of HCI, many companies express concern over the capabilities of their HCI environments, particularly regarding performance and scalability, along with data protection and disaster recovery features. In order to assess the capabilities of NetApp's HCI system, Evaluator Group was asked to evaluate it in our lab using a variety of typical enterprise workloads and use cases.

In this Lab Insight, we report on the findings of our in-depth testing of NetApp HCI in scenarios designed to represent typical usage in an enterprise hybrid cloud environment. Testing was designed to assess system usability, performance and Quality of Service (QoS) capabilities, along with scaling and availability. Additionally, the NetApp HCI system was evaluated during unplanned events in order to understand the potential impact to availability and performance.

In summary, the NetApp HCI system was able to leverage its disaggregated HCI design. Tested as a solution, the system was shown to scale storage performance and capacity independently from computing capabilities. Additionally, the impact of a storage failure was minimal while running a set of common virtual applications.

NetApp HCI Test Highlights:

- **Performance: Industry leading HCI storage performance (3 compute + 5 storage NetApp HCI)**
    - o IOmark-VDI: Certified for 3,200 VDI users IOmark-VDI standard storage workload
    - o IOmark-VM: Certified for 1,440 VM applications, using IOmark-VM storage workload
- **Scalability:** Ability to linearly scale capacity and performance of storage independently
- **Availability:** Tested ability to withstand storage node failure with minimal compute impact
- **Enterprise QoS:** Tested QoS control per volume and per VM (using iSCSI and VVOLs, respectively)
- **Always on Data Reduction:** All testing and results with data reduction enabled

Note: *IOmark testing certifies the storage performance of the system for a particular workload, without regard to the computing required. For NetApp-HCI with VDI or VM application workloads, sufficient compute nodes are required in order to fully utilize the storage performance and capacity delivered by the system tested. (See page #5 for details)*

Enterprise HCI

Enterprise users have rapidly adopted HCI as a means for rapidly deploying new applications using a common set of technologies and management interfaces. The high degree of integration is what enables IT administrators to deploy, scale and manage new application deployments much more efficiently than using older designs, processes and tools.

As HCI has matured, application owners and IT administrators have both gained confidence in these systems' capabilities to handle a wide variety of applications that were traditionally run on dedicated, highly customized systems.

Evaluator Group Comments: By utilizing separate processing for storage, compute node CPU is always available for application processing. The independent scaling of storage and compute capabilities, together with QoS provides application consistency.

Evaluator Group Research of Enterprise HCI

Evaluator Group conducts research into many areas of enterprise IT, including the usage of converged and hyperconverged infrastructure. Recent research results include factors for choosing and deploying CI and HCI, use cases and other topics. Some of the key insights gathered over the course of multiple studies include reasons companies are using both HCI and CI systems for an increasing number of applications. Some of top reasons cited for using HCI is the ability to consolidate equipment while reducing complexity and enabling faster deployment of new equipment.

Another rationale cited by many customers is the simplicity and manageability of HCI systems compared to both traditional IT and CI systems. However, in some instances customers are using CI due to its ability to flexibility in scaling compared with traditional HCI systems. These research studies are available to Evaluator Group clients on the website, **www.evaluatorgroup.com.**

In addition to current CI and HCI technologies, new methods for operating IT infrastructure are emerging, with container-based development and operation (dev/ops) gaining traction. However, the management of containers is relatively new and has not yet attained the maturity of more traditional methods for deploying and managing IT infrastructure.

As container technology matures, it is likely to play a role in some new applications, many of which are now being deployed on HCI infrastructure. Moreover, next generation container storage will need to provide many of the same features and capabilities as mainstream enterprise storage and HCI systems do currently. These capabilities include data protection, disaster recovery and differentiated quality of service and performance features. Thus, it is clear that IT administrators and application owners are both looking for solutions that enable them to flexibly deploy and manage applications with a consistent set of tools, while delivering the performance and reliability of traditional IT infrastructure.

Scaling Enterprise HCI

NetApp's HCI solution is different than many first generation HCI systems by utilizing independent resources for compute and storage. This architecture is often referred to as "disaggregated" in that it breaks apart some of the resources used to deliver an HCI platform. By separating resources, NetApp's HCI system is able to scale compute and storage performance independently, with almost no impact to other resources. Clearly, scaling performance is one advantage of disaggregation, but there are additional advantages including the ability to deliver high availability without impacting application performance.

The ability to insulate applications from each other has been a concern of application owners in shared environments, including for both virtualization and containers. For these reasons, many business-critical applications have resisted the use of shared resources, be that compute or storage. Isolation is one means of achieving predictable performance, although it comes at the price of reduced efficiency. The combination of dedicated storage processing insulates application demands from potential I/O delays for other applications, and the NetApp HCI QoS capabilities provide additional control for administrators and application owners. These enterprise-class features help enable cloud operators in both private and service provider environments to deliver consistent performance to applications regardless of what other workloads are running.

With traditional first generation HCI systems, compute resources are utilized to provide storage features including data protection, replication and high availability. Thus, when a node fails computing resources decrease, along with a reduction in storage availability, performance and capacity. Commonly, node failures place even higher demands on already degraded systems by forcing storage rebuilds, which consume additional resources and further diminish critical application resources. In contrast, NetApp's HCI uses independent resources for compute and storage, meaning a failure of a compute node does not reduce storage availability, performance or capacity. The NetApp HCI solution utilizes dedicated resources for compute and storage, each optimized to enable scaling while maintaining consistent performance characteristics, including during planned or un-planned outages.

Testing NetApp HCI

Test Environment

Evaluator Group extensively tested the NetApp HCI system in the Evaluator Group lab in early 2019. All equipment was located on-site with testing performed by Evaluator Group personnel. Initial setup and deployment was performed by NetApp personnel prior to arrival at the test facilities. All system administration, provisioning and testing was performed by Evaluator Group utilizing the provided user interfaces and plugins available for the NetApp HCI system. The primary interface for management is vCenter along with the HCI vCenter plugin that provides monitoring and administrative capabilities within vCenter. Additionally, the Element OS management UI was used for additional monitoring, and access to NetApp HCI specific capabilities.

The configured system included two, 2U 4-node chassis, along with two dedicated switches for node interconnections and connection into the main lab network. All storage was provided by the HCI storage nodes running ElementOS to the compute nodes running VMware vSphere. A high-level diagram of the test environment is shown in Figure 1.
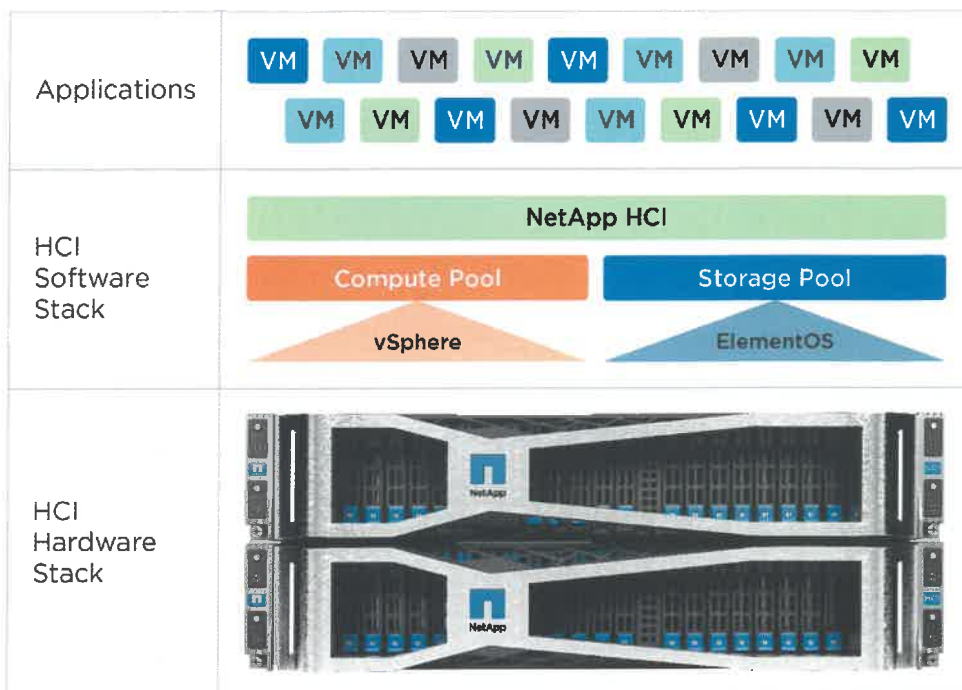

Figure 1: Test Environment – NetApp HCI

Test Results

Two application workloads were tested for performance, along with scalability, QoS and failure testing. All evaluations utilized the NetApp HCI environment depicted above, with either iSCSI or VMware VVOL storage for the virtual applications. Storage connectivity utilized multiple switched Ethernet connections between compute and storage nodes.

It is also notable that NetApp's performance results were achieved with deduplication and compression enabled, which is often disabled on competing HCI solutions during benchmark testing.

Evaluator Group Comments: The NetApp HCI proved its ability to deliver scalable performance, including the most VDI instances for any HCI system Evaluator Group has tested and the most VM instances of any HCI configuration under $1M. The NetApp HCI achieved these records with data reduction enabled, providing significant capacity savings. In contrast, competing HCI solutions often disable data reduction during benchmarking.

VM Workload

In order to assess the NetApp HCI's ability to support virtual applications, the IOmark-VM2 workload set was utilized. This standard benchmark measures the number of virtualized applications a storage system can support while still meeting application latency requirements. These certified results are available on the iomark.org website (www.iomark.org/sites/default/files/IOmark-VM_NetApp_HCI-VM_190802a.pdf).

These results are certified as a Hyperconverged solution, which assures the solution has sufficient storage, CPU and memory while meeting the application performance requirements.

- **NetApp HCI achieved 2nd highest IOmark-VM for hyperconverged systems**
- **IOmark-VM-HC certifies entire HCI system for 1,440 VM's at $454.86/ IOmark-VM-HC**
    - o Configuration: 18 compute nodes + 5 storage nodes
    - o System total = $655,000.00 ($655,000 / 1,440 = $454.86)

VDI Workload

Evaluator Group tested the NetApp HCI system using the IOmark-VDI "standard" workload set which measures the number of VDI instances a storage system is able to support while still meeting application latency requirements. These certified results are available on iomark.org website (www.iomark.org/sites/default/files/IOmark-VDI_NetApp_HCI-VDI_190802a.pdf).

These results are certified as a Hyperconverged solution, which assures the solution has sufficient storage, CPU and memory while meeting the application performance requirements.

- **NetApp HCI achieved the highest number of IOmark-VDI for hyperconverged systems**
- **IOmark-VDI-HC certifies entire HCI system for 3,200 desktops at $176.56 / IOmark-VDI-HC**
    - o Configuration: 12 compute nodes + 5 storage nodes
    - o System total = $565,000.00 ($565,000 / 3,200 = $176.56)

Additional Testing

In addition to VM and VDI workloads, Evaluator Group performed tests designed to understand the features and capability of the NetApp HCI system, including quality of service, scalability and error handling.

Scalability

Scaling performance is an important criterion for choosing cloud and hyperconverged infrastructure. The NetApp HCI was tested with 4 storage nodes and then scaled up to 5 storage nodes. The performance of the 4-node configuration was found to be approximately 20% lower than the 5-node configuration, using the IOmark-VM workload. More precisely, 5 storage nodes supported 1,440 VMs while 4 storage nodes supported 1,120 VMs at the required benchmark latency requirements. These results show that scalability was linear from 4 to 5 nodes and should continue scaling performance up to NetApp's supported configuration of 40 storage nodes.

VVOL and iSCSI

As stated, both iSCSI volumes and VMware VVOLs were used during testing. Some tests were repeated using both connectivity methods. We found no performance differences between the two methods of allocation. While many IT organizations prefer iSCSI due to its ubiquity and familiarity, VMware VVOLs provided several advantages.

Testing showed the following benefits of VVOLs:

- Improved manageability and reduction in administration time and number of actions required
    - Reduced storage admin. (appx. 1 hour to manually create 150 iSCSI volumes vs. 0 minutes with VVOLs)
    - No need to resize or delete datastores with VVOLs for configuration changes
- Ability to create native NetApp HCI snapshots using VMware tools
- Per VM and VMDK control of QoS and performance monitoring with VVOLs

> *Evaluator Group Comments: The use of VVOLs was not part of the test plan. However, the efficiency and manageability of VVOLs helped reduce the time to perform test setup, performance monitoring and QoS. NetApp HCI's support for multiple storage connectivity such as iSCSI, VVOLs and container native storage via Trident is a competitive advantage.*

Quality of Service

Another consideration in shared environments is the ability to manage application performance, both for groups of applications and individually in some instances. QoS settings are available both for iSCSI volumes and at the VM and VMDK (VM virtual disk) level when using VVOLs. In both cases, multiple settings were available including minimum I/O rate, maximum sustained I/O and burst I/O rates. Settings are established via policies available through the UI, which are then applied to volumes. For VMware VVOLs, policies are established using VMware vCenter policy settings, with policies then applied to VMs or individual VMDKs as desired. Testing verified that limits are enforced allowing business-critical applications to operate without restrictions, while limiting less critical applications.

In order to support dynamic environments, QoS settings may be modified and applied to running volumes and may be changed both via the UI and through the ElementOS API. This provides application and IT administrators the ability to respond to business requirements and changing workloads in real time.

Error Recovery

Evaluator Group tested failure scenarios, manually rebooting a storage node either by a power switch or via the UI. The results showed that when running a moderate workload, storage latencies increased slightly while the node rebooted and came back online. After a 5-minute restart process, the system resumed operating at full performance after an additional 5 minutes, without any further impact. NetApp HCI is designed to tolerate a node reboot without migrating data, thus imposing no additional

performance overhead on remaining nodes. The overall system continued operations without any loss of application or data access or workloads terminating.

NetApp HCI Overview

NetApp's HCI system is designed for enterprise environments that require the ability to scale storage performance and capacity independently from computing, in order to match application requirements efficiently. NetApp's HCI architecture provides enterprise capabilities along with NetApp Data Fabric components to extend usage, data protection and deployment options.

NetApp HCI Features

- **Independent Scale-Out** – Scale storage performance and capacity independently from compute
- **Data Efficiency** – In-line deduplication, compression and thin provisioning increase storage efficiency by 5 – 10x
- **Storage Capacity** – From 11.5 TB - 1.8 PB raw capacity (50 TB - 5 PB+ usable with data reduction)
- **Clustering** – Compute scales to 64 nodes per cluster, storage nodes scales from 4 – 40 nodes
- **Quality of Service** – Integrated QoS provides ability to control I/O to isolate applications
- **Data Resiliency** – Dual redundant copies of data distributed to all nodes, automated drive rebuilds
- **Data Protection** – Native snapshot-based backup and restore functionality to object storage via S3 or SWIFT compatible API
- **DR & Replication** – Synchronous, asynchronous and snapshot replication locally and between remote clusters
- **Availability** – Automated failover and failback available between a cluster and up to four other clusters
- **Data Security** – Encryption with 256-bit AES for environments requiring data at rest protection
- **Connectivity** – Storage connectivity via iSCSI, Fibre Channel, VVOL's, and container native storage via NetApp Trident
- **Deployments** – Public and private cloud deployments enterprise environments
- **Integration** – VMware vCenter, VAAI, VVOLs, SRM/SRA, Microsoft VSS Provider, PowerShell - Integrated with OpenStack, Containers and NKS via Trident framework

Recommended Deployments

NetApp HCI is designed for private cloud and multi-tenant environments supporting a wide range of applications including general purpose VMs, VDI, Oracle, SQL Server, and NoSQL databases on VMware with support for RedHat OpenShift Container platform. The inherent capabilities of NetApp HCI provide data resiliency and protection, along with disaster recovery and other high availability features. To minimize application impact on shared resources, the system provides quality of service features for fine-grained control of performance.

For container deployments, NetApp Trident provides native container storage connectivity and integrates with the NetApp Kubernetes Service (NKS) to extend on-premises NetApp HCI to a multi-cloud component. NetApp NKS on HCI provides a single point of management with a common framework for managing and deploying applications.

Evaluation Summary

The NetApp HCI system utilizes a disaggregated architecture to enable independently scaling storage and compute capabilities in an integrated HCI appliance. According to Evaluator Group's continuing survey of enterprise use of hyperconverged systems, many value HCI systems' ability to be deployed more rapidly than traditional equipment, along with the ability to reduce complexity. However, some IT users express concerns regarding the ability to scale HCI performance and inflexibility of some HCI systems.

The NetApp HCI provides the benefits of a hyperconverged architecture, with increased scale and flexibility features of converged infrastructure, by enabling independent scaling of both storage and computing capabilities. Additionally, the system can be extended to leverage NetApp Data Fabric services, such as ONTAP Select for HCI, to add file and the full set of ONTAP data services to NetApp HCI. For disaster recovery, NetApp HCI may use SnapMirror replication to a NetApp ONTAP system.

With ability to scale capacity and storage performance, the NetApp HCI systems offers a greater degree of flexibility than many competing HCI systems. Additionally, the disaggregated architecture also allows a greater degree of isolation between storage and application demands, which was demonstrated by both the QoS capabilities and the sustained operations during a storage node outage. Many competing HCI solutions require over-provisioning resources, such as using fully redundant clusters, in order to provide continued performance during a node failure. NetApp HCI's QoS feature allows the system to operate at *higher utilization*, while still ensuring less important applications do not impact more critical ones.

Moreover, NetApp HCI provides a highly efficient HCI solution that delivers proven VM application and VDI performance levels that surpass comparable alternatives and does so at better price / performance levels.

Appendix A -Configuration Details

Provided below are the specific components and configuration details of the test environment.

Compute Nodes:

- H410C compute node: 2 socket, 20 cores at 2.1 Ghz (total 40 cores)
- 768 GB Memory 24 @ 32 GB DRAM
- 2 x 10 GbE connectivity

Storage Nodes:

- H410S-31110 storage node: 5 nodes, each with 6 @ 480 GB SSD drives per node (30 drives total)
- Total of 48 TB of usable capacity available (without data reduction)

Hypervisor:

- VMware ESXi 6.5 hypervisor and VMware vCenter 6.5 management

Other Infrastructure:

- 2 x Mellanox SN2010 (redundant ethernet switches

Benchmark Workloads

- IOmark-VM (a storage benchmark with a mixture of 8 different virtualized applications)
- IOmark-VDI (a storage benchmark for virtual desktop VMs, each running multiple applications)

Appendix B - NetApp HCI Test Details
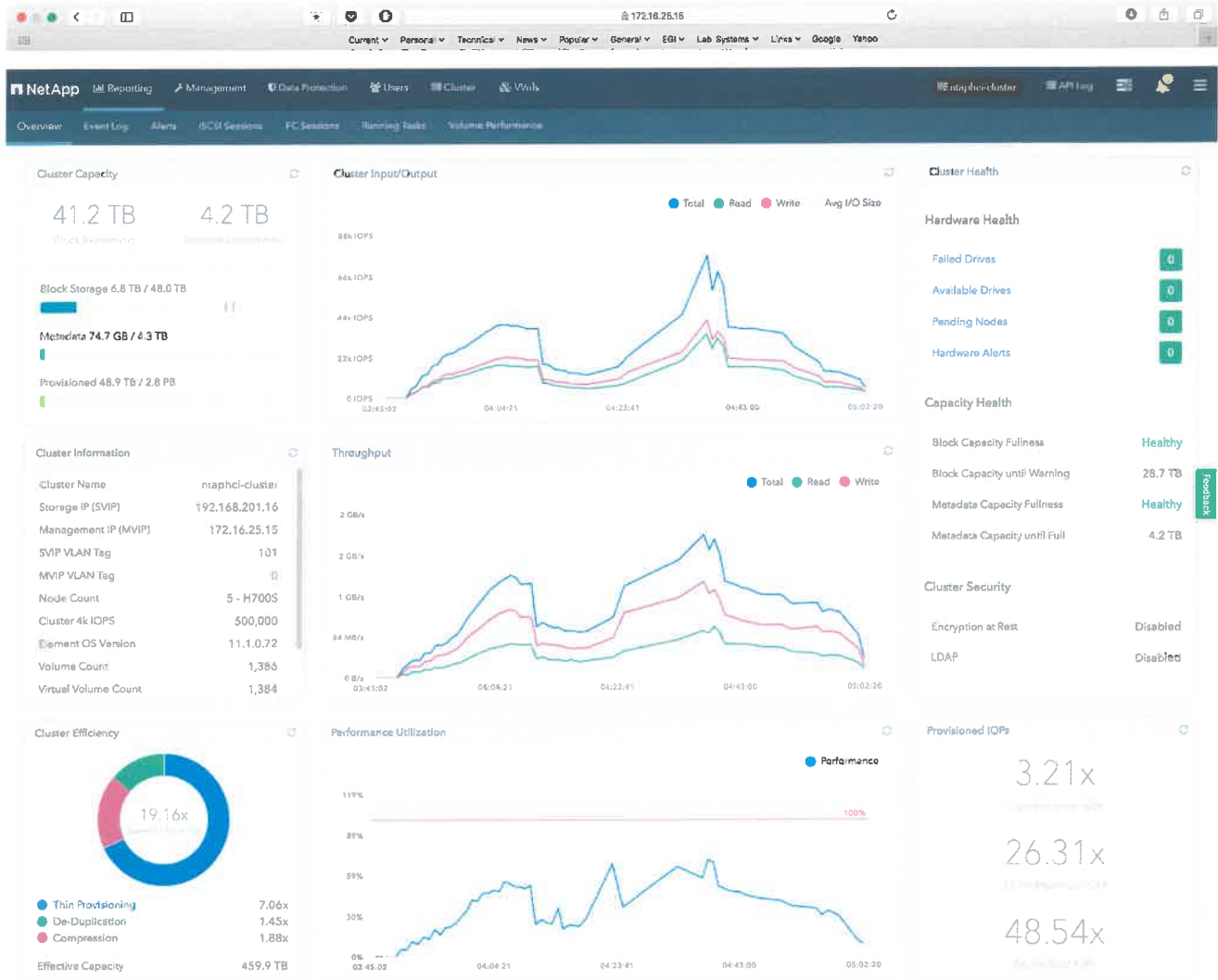
The NetApp HCI user interface is shown below in Figure 2.

Figure 2: NetApp HCI UI (standalone UI, vCenter plugin view is similar)

HCI Storage Node Reboot Testing

Shown below is a view from vCenter for each of the compute nodes, during the storage node reboot test. There was a momentary spike in latency when the node rebooted up to approximately 1,000 ms. lasting for about 30 seconds. After approximately 10 minutes, the node is back online and again there is a momentary increase in latency during rebalancing before returning to normal.
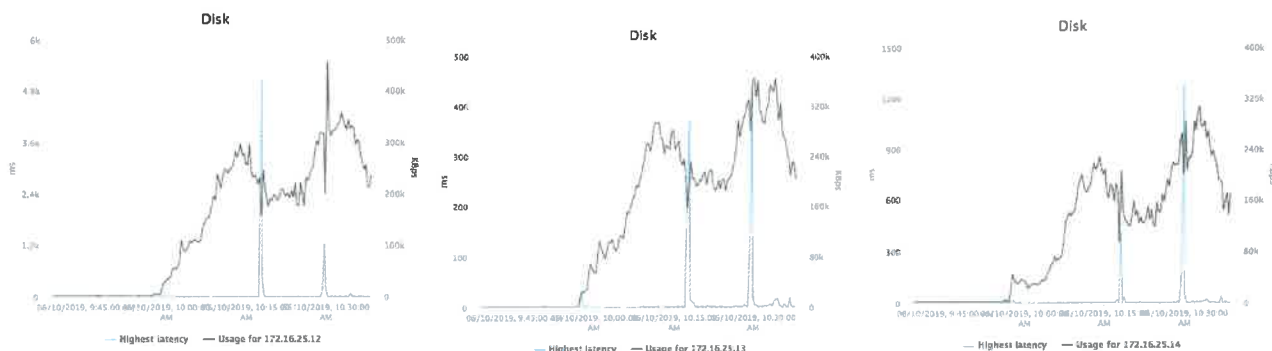

Figure 3: Storage I/O and Latency during node reboot (vCenter per host view)

NetApp HCI Pricing*:

Item	Description	Price	
NetApp HCI compute	NetApp compute nodes, ea.	$	15,000.00
NetApp HCI storage	NetApp storage nodes, ea.	$	77,000.00
Total	Configuration dependent	$	N/A

***Note**: The stated prices were provided as representative pricing as of June 2019. Pricing may change and listed systems and prices may no longer be available. NetApp HCI pricing provided by NetApp Inc.*

About Evaluator Group

Evaluator Group Inc. is dedicated to helping IT professionals and vendors create and implement strategies that make the most of the value of their storage and digital information. Evaluator Group services deliver in-depth, unbiased analysis on storage architectures, infrastructures and management for IT professionals. Since 1997 Evaluator Group has provided services for thousands of end users and vendor professionals through product and market evaluations, competitive analysis and education. www.evaluatorgroup.com Follow us on Twitter @evaluator_group

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White Paper

The Evolution of Hyperconvergence and NetApp's Role in this Rapidly Expanding Market

Sponsored by: NetApp

Eric Sheppard
October 2018

IN THIS IDC WHITE PAPER

This IDC white paper reviews important market trends that have driven rapid growth in global hyperconverged infrastructure (HCI) deployments. This paper outlines the ways in which hyperconvergence is evolving to become an enterprise-class datacenter platform capable of supporting the stringent demands of mission-critical and hybrid cloud environments. This paper also provides an overview of NetApp's HCI portfolio of solutions and a summary of an in-depth interview IDC conducted with a NetApp HCI customer.

SITUATION OVERVIEW

Companies that want to compete in today's rapidly changing digital environment must focus on innovative use of technology that drives organizational agility and business decisions that are based on high volumes of near-real time data. Simply stated, organizational agility and intelligent use of big data have become competitive differentiators. As such, companies around the world are undertaking digital transformation projects intended to streamline costs of doing business, strengthen customer relationships, capitalize on new sources of revenue and improve workforce productivity. For companies undertaking such digital transformation, this can mean a shift from a physical product to a subscription service, targeting an entirely new market or reaching new customers that brings a different level of scale. The impact of this transformation is far-reaching and difficult to overstate. All parts of a company (e.g., executives, lines of business, facilities, IT teams, software developers, and more) are expected to be contributors to this once-in-a-generation transformation by fundamentally rethinking organizational structures, processes and tools to better deal with the ever-increasing speed of business change.

The need to digitally transform has created immense pressure for datacenter teams that are increasingly expected to be leaders in this transformation. New leaders are evolving to become cloud architects so that they can meet the considerable pressure to mimic the best of public cloud within their datacenters (i.e., provide resources that are simple to manage, allocate and consume). Indeed, IT consumers have considerable experience with public cloud services and fully expect a comparable swipe-and-go process of dialing up services nearly instantly within their own organization's IT department. Further, developers and business leaders expect their IT teams to automate the provisioning of tuned IT resources for any workload at any location whenever needed. Demand for datacenter skills is shifting from those with expertise in 3-tier SANs (server, network, storage) to skills

commonly found within cloud architect communities. Simply stated, IT teams are forced to either adapt to a changing world where public cloud simplicity is the norm or face becoming obsolete.

The rapid increase of infrastructure convergence is driven by its ability to address many of the datacenter challenges outlined above. Those that have deployed converged infrastructure are benefiting from increased IT staff productivity, improved business agility and the ability to support a modern hybrid cloud solution. Early convergence of datacenter infrastructure focused almost entirely on integration, autonomous compute, storage, and networking systems. This convergence expanded with the introduction of software-defined, scale-out solutions that drove further operational simplicity through automation and reduced complexity. These newer solutions, known as hyperconverged infrastructure (HCI) brought considerable benefits, but often came with fewer capabilities than their legacy counterparts. Only recently have we begun to see a new generation of hyperconverged solutions that combine the benefits of scale-out, software-defined architectures with mature, enterprise-class data services. IDC believes this represents a new phase, or second chapter of the HCI market. An overview of how we have gotten to this newer generation of HCI solutions, what is expected of a modern HCI solution, and the considerable benefits they offer, is provided in the sections that follow.

The Evolution of Datacenter Infrastructure Convergence

Datacenter teams are finding that the levels of scale, simplicity and agility needed to support complex digital transformation initiatives simply cannot be achieved using their long-standing practice of buying individually managed silos of datacenter resources, or just following the "check box" next to things like APIs. As a result, IT organizations around the world are shifting their resources away from standalone servers, networking, and storage systems in favor of converged infrastructure solutions that can be centrally managed with tools that offer new levels of automation. IDC has been covering the converged systems market for nearly a decade. During this time, solutions in this market have proven to be a very effective way to improve datacenter resource utilization, increase IT staff productivity, improve business agility, and reduce time-to-services.

Converged systems represent a consolidation of core datacenter technologies (servers, storage systems, networking and management software) into a single system that can be deployed, managed, and supported more efficiently than buying and building these technologies separately. Converged systems help to remove complexity and risk associated with managing enterprise-grade datacenter infrastructure so that IT teams can confidently focus their time on higher-value projects and tasks.

The adoption of converged systems has grown quickly during the past decade, with annual spending on converged systems now more than $13 billion, with the market expanding faster than the larger datacenter infrastructure market. This type of market expansion is a clear indication of the degree to which converged systems can drive real benefits within the datacenter. That said, most of the traditional converged systems in use today are built with well-tested, but discrete server, storage and storage networking as their core building blocks. Such systems have undeniably helped push datacenter infrastructure convergence into the most demanding, mission-critical applications in use today. The use of discrete systems as core building blocks has also kept average selling prices (ASPs) of traditional converged systems relatively high. IDC data shows ASPs of converged systems built with discrete server, storage and storage networking components above $350,000 for the complete solution. While such ASPs have not impeded the continued expansion of converged systems, they have held back adoption within many organizations looking for smaller starting points and more granular building blocks.

Datacenter Convergence Evolves and Expands to Include Hyperconvergence

Like today's IT departments, the converged systems market is rapidly evolving. An important element of this evolution is the relatively recent emergence of hyperconverged infrastructure (HCI), which IDC considers a subset of the $13 billion converged systems market and the next phase of the market's lifecycle. HCI solutions deliver the proven benefits of traditional converged systems, but do so through a software-defined, scale-out architecture. HCI solutions are built as clusters of commodity servers (x86) that provide an abstracted pool of capacity, memory, and CPU cores that are used as the foundation for server-centric workloads (the hypervisor, VMs and applications) as well as storage-centric workloads (e.g., data persistence, data access and data management).

HCI deployments are driving benefits in the following key areas:

- **Lower capex.** Lower capex can be achieved through the elimination of SAN-based storage solutions in favor of industry standard servers that offer fully virtualized compute and data services. The scale-out architecture of hyperconverged solutions further lowers capital costs by helping to reduce the need to overprovision resources. Instead, customers can buy only the nodes required at the time of initial deployment and scale later as needed.
- **Reduced opex.** Reduced overprovisioning and elimination of storage silos have positive impacts beyond capex. In fact, these benefits can directly lead to lower costs of power, cooling and floor space within the datacenter. HCI solutions often integrate management software that automates many of the complex tasks needed during initial deployment while also reducing the number of steps required to provision new workloads. The result is improved IT staff productivity and increased agility within the datacenter. These same solutions also help IT departments to leverage IT generalists for low-value tasks, thus freeing up time for infrastructure specialists to work on more innovative projects.
- **Reduced risk.** The highly automated nature of HCI solutions also helps to reduce risk of downtime associated with common lifecycle management tasks (e.g., firmware upgrades, system refresh). The scale-out, software-defined nature of HCI solutions help to eliminate the need for complex and risky forklift upgrades, which have become all too common within the datacenter. Many companies leverage hyperconverged solutions as a way to improve their DR/HA processes and costs in ways not possible just a few short years ago. Lastly, HCI solutions allow users to reduce the number of technology suppliers involved within a full solution, which helps to better coordinate patches and upgrades while also reducing the number of support calls needed for the solution.

Evolution of Hyperconvergence

First made popular by public cloud operators like Google, Microsoft and Amazon, hyperconvergence emerged as a modern converged infrastructure architecture for next-generation applications. Smaller companies that were "born in the cloud" ignited further demand for scale-out, software-defined HCI systems. Meanwhile, established enterprises around the world began demanding the benefits that an HCI approach can provide – that of scale, automation and agility. On prem, HCI solutions found early success within midsize companies, remote office/branch office (ROBO) environments and virtual desktop infrastructure (VDI) projects due largely to their ability to eliminate the complexity, expense and latency often associated with SAN-based storage solutions. Awareness of the benefits these solutions bring to the table has risen steadily among enterprise IT teams, resulting in increased market adoption. Once deployed, IT teams frequently expand the set of workloads running on HCI. This considerable growth of new hyperconverged deployments and expansion of workloads running on these systems has helped to drive global sales of hyperconverged solutions (including hardware and

software) beyond $4.9 billion during the twelve months ending June 30, 2018, up 72.3% year-over-year. Importantly, the expansion of workloads running on hyperconverged solutions has brought with it new requirements. Today's HCI solutions are expected to perform predictably while supporting a larger number of workloads with differing I/O profiles. Today's HCI solutions are now expected to support mission-critical applications (e.g., SAP or Oracle), which translates into application resiliency at the system and multi-site level. A more complete overview of the requirements expected of a modern HCI solution is provided in the next section.

Although not widely realized, the hyperconverged market is entering a new phase of maturity. In contrast to the early years of deployments, investment in HCI solutions are increasingly targeting mission-critical workloads, are larger in scale, and are in use by a wide range of companies. Based on past IDC surveys, business applications (e.g., ERM, CRM, supply chain management, financial management, payroll/accounting) were the most common workloads running on HCI solutions. Other common applications running on HCI include collaborative and content applications, structured data analytics and structured data management applications. Moving forward, IDC expects the use of HCI solutions for mission-critical business applications to expand considerably.

Requirements of a Modern Hyperconverged Solution

While the types of workloads running on hyperconverged solutions are a good indication of how far the HCI market has come since its early days, there is more that must be offered to drive further expansion of this market. Modern HCI solutions must close important feature/capability gaps that exist with traditional datacenter infrastructure, enable an IT departments shift towards private cloud infrastructure and support an increasing need for organizational transformation within the datacenter. The following bullets offer an overview of the most important attributes and capabilities a modern HCI solution must provide to ensure relevance as users push for expanded HCI use cases within their datacenter:

- **Eliminate "noisy neighbors."** As outlined earlier, organizations are expanding the use of HCI solutions. With the expanded use of hyperconverged infrastructure comes the need for HCI solutions that support an increased density of primary workloads. Thus, one of the most critical feature gaps that HCI solutions must address is support for predictable and guaranteed performance levels within such environments. With increased workload density comes the increased risk of resource contention. For hyperconverged solutions to thrive during this next phase of hyperconverged adoption, they must consistently deliver sub-millisecond response times and support hundreds of thousands to millions of IOPS. This is creating the need for a workload protection engine to address "noisy neighbor" issues and ensure that performance can be consistently delivered as required, no matter what else is going on in the system.

- **Integration with multiple public clouds.** Modern HCI solutions must provide a private cloud platform that can be easily integrated with hyper-scale public cloud providers to create a seamless hybrid, multi-cloud experience. Features required to achieve this include:
  - Use of service catalogs that support on-prem resource and workload deployment
  - Support for highly portable workloads and automated bursting
  - Ability to seamlessly move data between on-prem, private clouds and public clouds to support the ever-changing needs of a diverse workload portfolio
  - Seamlessly collapse management complexity to better support the lifting and shifting of applications from private clouds to trusted hyper-scalers and back again as business requires
  - Support for containers to accelerate development of new services

- Support for chargeback of resource utilization

- **Common data fabric for private and public clouds.** IDC believes hyperconverged solutions have become an ideal platform for on-prem, private cloud deployments thanks to their scale-out, software-defined, highly automated architecture. But it is important to recognize that the role of customers' cloud-based IT solutions is to ingest, deliver, and exploit data no matter where that data is created or lives. Thus, a truly optimized hyperconverged-based private cloud should be considered a component of a broader, hybrid public/private cloud ecosystem that provides a "lingua franca" (or data fabric) that supports common data services for efficient placement, movement and use of data across a true hybrid multi-cloud environment. Such a data fabric allows IT departments to incorporate newly deployed HCI solutions in their datacenters without creating additional management silos.

- **Enabler of organizational transformation.** IDC notes that modern hyperconverged solutions are also increasingly looked upon to support organizational transformation within the datacenter. Therefore, modern HCI solutions must support consolidation of datacenter jobs/roles so that one administrator can take on the responsibility for virtualization, compute and storage. This consolidation of roles will help to free up time within the IT team for more innovative projects and ultimately help shift human capital to other critical parts of the datacenter that drive innovative, new revenue streams and customer touchpoints rather than just maintaining status quo.

- **Independent resource scaling.** Many HCI solutions scale by requiring an additional node that would increase compute and storage resources together. This is commonly referred to as linear scaling. The problem with this is no datacenter grows in a linear way across all the pools. There are times when there is need for additional compute or additional capacity, but not both. To address these increasingly diverse needs, HCI solutions must evolve into a more elastic solution. If an environment becomes "storage intensive" or "compute intensive," the infrastructure must be able to support this without stranding resources or requiring users to add a full node with more compute or capacity than is required.

OVERVIEW OF NETAPP'S HCI PORTFOLIO

NetApp announced its entrance into the rapidly growing HCI market in June of 2017, with its solutions becoming generally available in October of the same year. NetApp HCI represents a portfolio of fully integrated HCI solutions that support a wide range of configurable CPUs, GPUs, memory and storage capacity through compute and storage nodes. Based on SolidFire and its Element software first released in 2012, NetApp HCI was built in the cloud, for the cloud.

NetApp has designed its HCI solution to align with the evolving demands of hyperconvergence outlined above. The following is an overview of key features NetApp HCI provides:

- **Workload protection.** The underlying storage technology in NetApp HCI is Element software. Element software, core to NetApp HCI's architecture, allows for workload protection for every application consolidated on NetApp HCI through Element's QoS. NetApp HCI delivers guaranteed application performance for multiple workloads, allowing customers to consolidate many applications on it rather than using it for single workloads and creating more silos in the datacenter. Element software also brings mature data services and integration capabilities such as integrated replication, data protection, data reduction and high-availability services to HCI. Another highlight is Element software's API integrations on VMware stack, allowing simple centralized management through a vCenter plug-in that gives full visibility and control

over the entire infrastructure. NetApp HCI also supports ONTAP Select out of the box, giving ONTAP users the opportunity to continue using it on HCI. As workloads are dynamic and unpredictable, customers should use performance monitoring tools and metrics to correctly provision storage and compute to ensure performance.

- **Independent scaling.** NetApp HCI offers the flexibility of scaling compute or storage nodes independently with simplified choices of small, medium or large nodes. This allows users to decouple compute and storage capacity scaling. IDC believes this granular level of scaling helps to eliminate the overprovisioning resources common within systems that scale linearly rather than independently.

- **NetApp Data Fabric.** Data Fabric is NetApp's unified suite of data services that provide consistent data services across traditional on-premise, private clouds and public cloud platforms. Based on NetApp's well tested, enterprise class ONTAP software, this data fabric provides users with the "lingua franca" required to move data seamlessly and securely between different locations, architectures and cloud platforms -- whether on-premises or within a public cloud. Expanding Data Fabric to its HCI solutions eliminates management silos common within many HCI solutions deployed alongside traditional data center infrastructure.

- **Automated deployment and management.** All NetApp HCI solutions come with a NetApp Deployment Engine (NDE), which reduces nearly 400 manual deployment steps down to less than 30 highly automated steps. Further, NetApp HCI solutions provide full integration with VMware vCenter via a plug-in, which makes ongoing management intuitive to a vast universe of VMware administrators. NetApp HCI leverages Element software APIs for highly automated integration into higher-level management, orchestration, backup, and disaster recovery tools.

- **Support for multi-hybrid cloud (Future).** Although a future feature at the time this paper was written, NetApp has announced that it will support multi-hybrid clouds through deployments of an on-premise region or a fourth hyperscaler to create a pool of cloud data services that can be accessed across hybrid multi-cloud and multiple private clouds.

Highlights from an In-Depth Interview with a NetApp HCI Customer

As previously noted, IDC interviewed a NetApp HCI customer to better understand how the solution is used in a real-world setting. The following is a short overview of that customer interview.

IDC interviewed a datacenter architect of a large U.S.-based hospital with more than 9,000 employees. There are two IT groups within the hospital that support general IT and research IT, respectively. This overview covers only the portion of the hospital supported by the general IT team. There are 175 staff members within this general IT team who manage 800 applications -- of which 90% have been virtualized. These applications run on 350 physical servers and 1.4 petabytes of storage capacity. The hospital's general IT team manages two datacenters.

The hospital has deployed three NetApp clusters with a total of 42 compute nodes and 14 storage nodes. All three clusters were deployed to support the hospital's VDI. Two clusters were deployed to support 4,000 users (2,000 users per cluster); the third cluster supports 500 remote desktop session hosts (RDSH). The number of sessions supported will vary throughout the day, with concurrent sessions expected to reach peaks of 2,500 to 3,000 users. The vast majority of users supported will be a part of the clinical staff (e.g., nurses, doctors, x-ray technicians), with the IT staff also expected to make up a small of portion of sessions running simultaneously. All users are clustered into one of six types of use cases, based on their role within the organization. A total of 50 desktop applications are supported.

The hospital's initial HCI deployment was triggered by a project intended to increase the number of virtual desktops from 500 to 4,000 within the hospital. The goal of expanding the number of virtual desktops was to maximize the amount of time clinicians spent focusing on patient care. Moving 4,000 users to a virtual desktop environment greatly improved the workflow of hospital staff, who are now able to leverage features such as "batch sign-in," "follow me desktops," and "follow me printing."

This VDI expansion project provided the opportunity to explore new technology suppliers for the hospital's VDI software and hardware. The IT team considered HCI from the very beginning of this project due to the relatively small size of their datacenters. HCI proved to be an effective way to support a large number of VDI users within a very small footprint.

Solutions from multiple HCI providers were considered before the IT team decided upon NetApp HCI. NetApp's solution won out over all others, in part, because of its ability to scale compute and storage independently. The hospital's VDI architecture required a large amount of compute, but a relatively limited amount of storage. With NetApp HCI, the datacenter architect stated, "when we expand, we want to be sure that we only needed to expand the resources needed." While need to expand hasn't yet surfaced, the datacenter architect expects additional compute resources to be needed far more often than additional storage capacity. Thus, NetApp HCI has provided a solution that aligns well with the expected asymmetrical growth of resources and limits the need to buy unneeded storage capacity.

Initial deployment of NetApp HCI was very quick. The high degree of automation provided by the NetApp Deployment Engine allowed the datacenter architect to deploy and configure all 42 HCI hosts during a lunch break. This included all aspects of the initial infrastructure deployment, including installing ESXi software and creating the pools of storage capacity. When referencing the ease of deploying NetApp HCI, the datacenter architect said, "I went through a wizard, clicked 'OK' multiple times and then went to lunch. When I came back, everything was deployed." He went on to say, "this type of one-touch deployment was lovely." When asked to compare this process to deploying traditional solutions, IDC was told that the NetApp HCI deployment required far less effort, time and risk. NetApp HCI automated steps that were previously highly manual and siloed by technology.

When asked about any operational benefits related to the deployed NetApp HCI solutions, IDC was told that the solutions are not yet running in full production. As such, it was still too early to provide a complete set of metrics that quantify the operational savings from on-going management of the NetApp solution. That said, the datacenter architect was able to point to considerable benefits related to the steps required to create a datastore for a new host/application. In the past, creating a new datastore required many manual steps that included the creation of a LUN, configuring storage networking, presenting the LUN to a host and allowing the host to format the raw capacity. Now, with NetApp HCI, all these steps have been eliminated. Instead, the users are presented with a wizard that asks a few basic questions and then automatically runs through the set of previously manual steps. Further, because the HCI solution is highly consolidated, there is no need to coordinate multiple teams to build out a new host and provision storage for that host. Instead, one person can utilize the NetApp Deployment Engine. When asked to quantify how much time can be saved with the automation enabled by NetApp's Deployment Engine, IDC was told: "Including the coordination of teams, we've taken a three-day process down to just three minutes."

Lastly, IDC explored the hospital's plans to expand its use of NetApp HCI. We were told that the CIO is currently considering expanding the use of VDI on NetApp HCI from 4,000 users to more than 9,000 users. We were also told that the use of NetApp HCI could be expanded to support non-VDI applications after the current deployment had operated an ample amount of time within production.

Ultimately, the datacenter architect sounded optimistic by stating: "We have the option of expanding it to quite a few other areas within the hospital, to the point that it could become the standard for us."

Ultimately, IDC was told that the IT team was very happy with the experience with NetApp HCI. The solution exceeded expectations in key areas such as the amount of compute power and storage capacity contained within the small footprint, and the ease with which an ESX could be deployed. When referencing these experiences, the datacenter architect jokingly stated, "It's *almost* made me lazy." Jokes aside, this hospital's experience with NetApp HCI is indicative of the type of benefits frequently highlighted by organizations that have started down a similar path. And while this hospital is still working through the final production rollout of NetApp HCI, its decision to deploy NetApp HCI is already driving considerable savings.

CHALLENGES AND CONCLUSION

The first generation of HCI solutions were primarily driving operational simplicity and rapid time to service. This addressed critical pain-points related to complexity and inflexibility within the datacenter. However, as with any early market deployments, users were often creating silos of HCI clusters for specific applications and use cases. Companies now want to increase the workload/VM density of their HCI clusters to get the most out of their investments. As such, HCI solutions will need to evolve to address many of the challenges that the first-generation solutions were not designed to tackle, such as workload consolidation, independent and flexible scaling, and predictable performance.

Looking forward, datacenter infrastructure will be increasingly influenced by software-defined solutions running on server-based platforms that incorporate hybrid cloud into an administrator's workflow. While this change has undeniably begun, it is still in its early days. IT teams that do not yet feel ready to deploy this type of infrastructure should keep an eye on the future and work closely with companies like NetApp to make sure today's datacenter investments prepare the datacenter for such inevitabilities.

Organizations ready to move forward with hyperconverged solutions should look for solutions that expand the traditional operational simplicity benefits to also include next-generation features outlined in this paper, such as workload protection, seamless integration with public clouds, a common data fabric between private and public clouds, and independent resource scaling.

About IDC

International Data Corporation (IDC) is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications and consumer technology markets. IDC helps IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy. More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide. For 50 years, IDC has provided strategic insights to help our clients achieve their key business objectives. IDC is a subsidiary of IDG, the world's leading technology media, research, and events company.

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