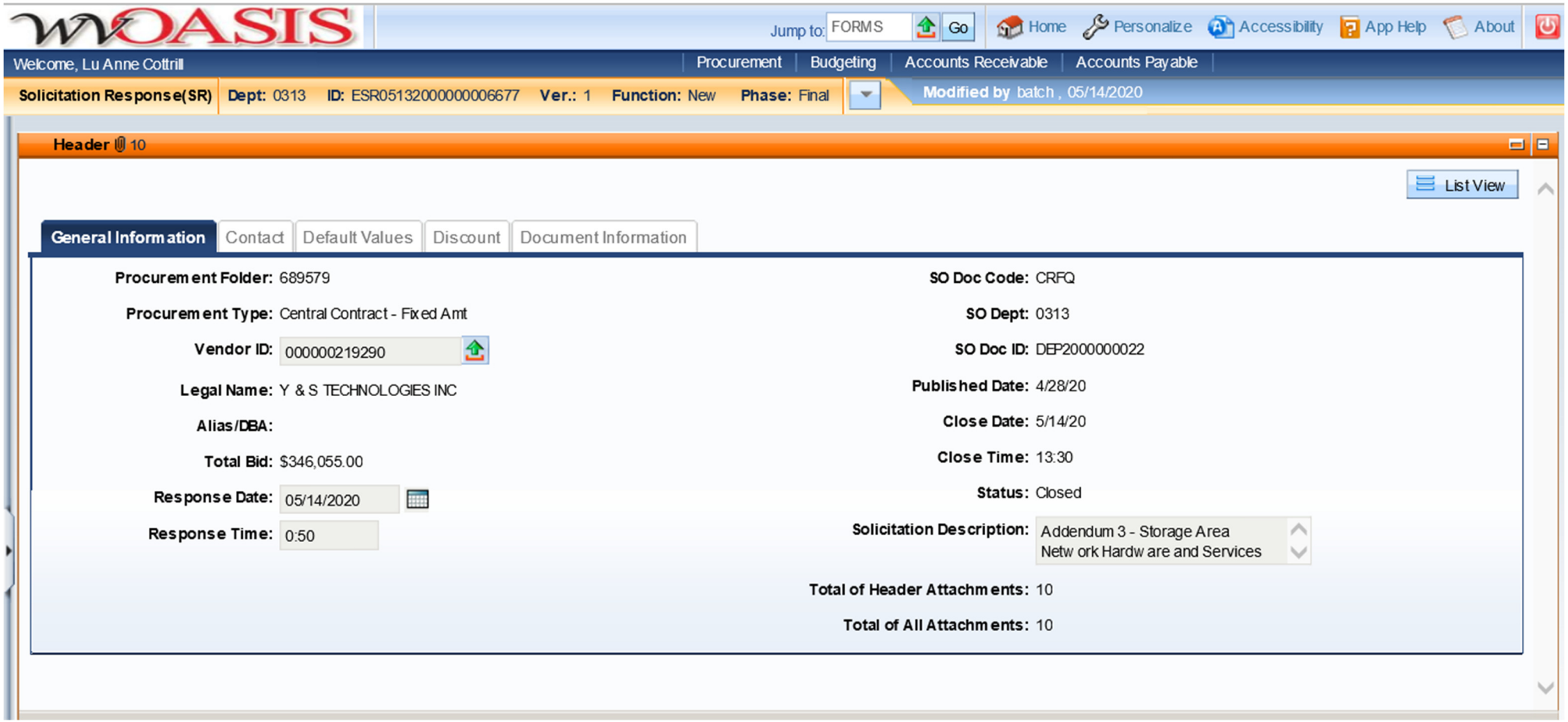
The following documentation is an electronically-submitted vendor response to an advertised solicitation from the *West Virginia Purchasing Bulletin* within the Vendor Self-Service portal at ***wvOASIS.gov***. As part of the State of West Virginia's procurement process, and to maintain the transparency of the bid-opening process, this documentation submitted online is publicly posted by the West Virginia Purchasing Division at ***WVPurchasing.gov*** with any other vendor responses to this solicitation submitted to the Purchasing Division in hard copy format.


wvOASIS
Jump to: FORMS Go
Home
Personalize
Accessibility
App Help
About
Welcome, Lu Anne Cottrill
Procurement
Budgeting
Accounts Receivable
Accounts Payable
Solicitation Response(SR) Dept: 0313 ID: ESR05132000000006677 Ver.: 1 Function: New Phase: Final
Modified by batch , 05/14/2020
Header 10
List View
General Information
Contact
Default Values
Discount
Document Information
Procurement Folder: 689579
Procurement Type: Central Contract - Fixed Amt
Vendor ID: 000000219290
Legal Name: Y & S TECHNOLOGIES INC
Alias/DBA:
Total Bid: $346,055.00
Response Date: 05/14/2020
Response Time: 0:50
SO Doc Code: CRFQ
SO Dept: 0313
SO Doc ID: DEP2000000022
Published Date: 4/28/20
Close Date: 5/14/20
Close Time: 13:30
Status: Closed
Solicitation Description: Addendum 3 - Storage Area Netw ork Hardw are and Services
Total of Header Attachments: 10
Total of All Attachments: 10

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

State of West Virginia
Solicitation Response

Proc Folder : 689579

Solicitation Description : Addendum 3 - Storage Area Network Hardware and Services

Proc Type : Central Contract - Fixed Amt

Date issued	Solicitation Closes	Solicitation Response	Version
	2020-05-14 13:30:00	SR 0313 ESR05132000000006677	1

VENDOR

000000219290

Y & S TECHNOLOGIES INC

Solicitation Number: CRFQ 0313 DEP2000000022

Total Bid : $346,055.00 **Response Date:** 2020-05-14 **Response Time:** 00:50:43

Comments: We are offering items and services that meet all specification requested.

FOR INFORMATION CONTACT THE BUYER

Guy Nisbet

(304) 558-2596
guy.l.nisbet@wv.gov

Signature on File **FEIN #** **DATE**

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

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Ln Total Or Contract Amount
1	Storage Area Network Hardware and Services				$338,459.00

Comm Code	Manufacturer	Specification	Model #
43212200			

Extended Description : Storage Area Network Hardware and Services for Storage Array's for Charleston and Logan. All professional services related to this solicitation (hardware installation, configuration and updating, software installation, software licensing, migration services and any additional equipment needed to complete with this solicitation) must be bid as a lump sum. Storage Area Network Hardware, and first (1) year Licenses and Support Services.

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Ln Total Or Contract Amount
2	Support for storage array - renewal for year two (2) support				$0.00

Comm Code	Manufacturer	Specification	Model #
56112005			

Extended Description : Support for storage array, 24x7 remote and on-site support renewal for year two (2) support

Comments: Included In Line Item 1

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Ln Total Or Contract Amount
3	Support for storage array-renewal for year three (3) support				$0.00

Comm Code	Manufacturer	Specification	Model #
56112005			

Extended Description : Support for storage array, 24x7 remote and on-site support renewal for year three (3) support

Comments: Included In Line Item 1

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Ln Total Or Contract Amount
4	Support for storage array- renewal for year four (4) support				$7,596.00

Comm Code	Manufacturer	Specification	Model #
56112005			

Extended Description : Support for storage array, 24x7 remote and on-site support renewal for year four (4) support

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: 689579

Doc Description: Addendum 3 - Storage Area Network Hardware and Services

Proc Type: Central Contract - Fixed Amt

Date Issued	Solicitation Closes	Solicitation No	Version
2020-04-28	2020-05-14 13:30:00	CRFQ 0313 DEP2000000022	4

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:

KSTechnologies 8313 Kings Hwy Ave Sec #357
Brooklyn NY 11213 718-473-0284 X203

FOR INFORMATION CONTACT THE BUYER

Guy Nisbet
(304) 558-2596
guy.l.nisbet@wv.gov

Signature X [signature] **FEIN #** 611569225 **DATE** 05/13/2020

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

ADDITIONAL INFORMATION:

Addendum

Addendum No.03 issued to publish and distribute the attached information to the vendor community.

****

Request for Quotation
(WV DEP Storage area Network Hardware and Services Project)

In accordance with WV Code 5A-3 The West Virginia Purchasing Division is soliciting bids on behalf of West Virginia Department of Environmental Protection to establish a contract for Storage Area Network Hardware and Services.

The WVDEP has existing production storage and integrated network infrastructure at its Kanawha City Building in Charleston, WV. New storage will be at both Charleston, WV for (production) and Logan, WV for (offsite backup). The Charleston address is 601 57th Street SE Charleston WV 25304. The address of the Logan site is 1101 George Kostas Dr. Logan, WV 25601 per the bid requirements, specifications, and terms and conditions as attached hereto.

INVOICE TO	SHIP TO
ENVIRONMENTAL PROTECTION OFFICE OF ADMINISTRATION 601 57TH ST SE CHARLESTON WV25304 US	ENVIRONMENTAL PROTECTION 601 57TH ST CHARLESTON WV 25304 US

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
1	Storage Area Network Hardware and Services			$338,459.00	$338,459.00

Comm Code	Manufacturer	Specification	Model #
43212200	Lenovo	As requested	7Y42S0TL00

Extended Description :

Storage Area Network Hardware and Services for Storage Array's for Charleston and Logan. All professional services related to this solicitation (hardware installation, configuration and updating, software installation, software licensing, migration services and any additional equipment needed to complete with this solicitation) must be bid as a lump sum. Storage Area Network Hardware, and first (1) year Licenses and Support Services.

INVOICE TO	SHIP TO
ENVIRONMENTAL PROTECTION OFFICE OF ADMINISTRATION 601 57TH ST SE CHARLESTON WV25304 US	ENVIRONMENTAL PROTECTION 601 57TH ST CHARLESTON WV 25304 US

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
2	Support for storage array - renewal for year two (2) support			Included in Line 1	

Comm Code	Manufacturer	Specification	Model #
56112005			Included in Line 1

Extended Description :

Support for storage array, 24x7 remote and on-site support renewal for year two (2) support

INVOICE TO	SHIP TO
ENVIRONMENTAL PROTECTION OFFICE OF ADMINISTRATION 601 57TH ST SE CHARLESTON WV25304 US	ENVIRONMENTAL PROTECTION 601 57TH ST CHARLESTON WV 25304 US

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
3	Support for storage array-renewal for year three (3) support			Included in line 1	

Comm Code	Manufacturer	Specification	Model #
56112005		Included in line 1	

Extended Description :
Support for storage array, 24x7 remote and on-site support renewal for year three (3) support

INVOICE TO	SHIP TO
ENVIRONMENTAL PROTECTION OFFICE OF ADMINISTRATION 601 57TH ST SE CHARLESTON WV25304 US	ENVIRONMENTAL PROTECTION 601 57TH ST CHARLESTON WV 25304 US

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
4	Support for storage array- renewal for year four (4) support			$7,596.00	$7,596.00

Comm Code	Manufacturer	Specification	Model #
56112005	Lenovo	4 year warranty	see Proposal

Extended Description :
Support for storage array, 24x7 remote and on-site support renewal for year four (4) support

ADDITIONAL TERMS AND CONDITIONS

See attached document(s) for additional Terms and Conditions

DESIGNATED CONTACT: Vendor appoints the individual identified in this Section as the Contract Administrator and the initial point of contact for matters relating to this Contract.

Saal Finck Sales Manager
(Name, Title)

Saal Finck Sales Manager
(Printed Name and Title)

383 Kingston Ave Ste #357 Brooklyn NY 11213
(Address)

718-473-0284 x203 718-360-9627
(Phone Number) / (Fax Number)

saal@yandstech.com
(email address)

CERTIFICATION AND SIGNATURE: By signing below, or submitting documentation through wvOASIS, I certify that I have reviewed this Solicitation in its entirety; that I understand the requirements, terms and conditions, and other information contained herein; that this bid, offer or proposal constitutes an offer to the State that cannot be unilaterally withdrawn; that the product or service proposed meets the mandatory requirements contained in the Solicitation for that product or service, unless otherwise stated herein; that the Vendor accepts the terms and conditions contained in the Solicitation, unless otherwise stated herein; that I am submitting this bid, offer or proposal for review and consideration; that I am authorized by the vendor to execute and submit this bid, offer, or proposal, or any documents related thereto on vendor's behalf; that I am authorized to bind the vendor in a contractual relationship; and that to the best of my knowledge, the vendor has properly registered with any State agency that may require registration.

Y&S Technologies
(Company)

Saal Finck Sales Manager
(Authorized Signature) (Representative Name, Title)

Saal Finck Sales Manager
(Printed Name and Title of Authorized Representative)

05/10/2020
(Date)

718-473-0284 x203 718-360-9627
(Phone Number) (Fax Number)

ADDENDUM ACKNOWLEDGEMENT FORM
SOLICITATION NO.:

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)

- [x] Addendum No. 1
- [x] Addendum No. 2
- [x] Addendum No. 3
- [ ] Addendum No. 4
- [ ] Addendum No. 5
- [ ] Addendum No. 6
- [ ] Addendum No. 7
- [ ] Addendum No. 8
- [ ] Addendum No. 9
- [ ] 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.

K STechnologies
Company

Authorized Signature

05/10/2020
Date

NOTE: This addendum acknowledgement should be submitted with the bid to expedite document processing.

SPECIFICATIONS

1. **PURPOSE AND SCOPE:** The West Virginia Purchasing Division is soliciting bids on behalf of West Virginia Department of Environmental Protection to establish a contract for Storage Area Network Hardware and Services.

   CURRENT ENVIRONMENT: The WVDEP has existing production storage and integrated network infrastructure at its Kanawha City Building in Charleston, WV. New storage will be at both Charleston, WV for (production) and Logan, WV for (offsite backup). The Charleston address is 601 57th Street SE Charleston WV 25304. The address of the Logan site is 1101 George Kostas Dr. Logan, WV 25601. The Charleston site has a computer room with several racks of equipment. ***The existing Storage System is an EMC VNX 5300 OEM S/N APM00120601959.***

2. **DEFINITIONS:** The terms listed below shall have the meanings assigned to them below. Additional definitions can be found in section 2 of the General Terms and Conditions.

   2.1 "Contract Services" means Storage Area Network Hardware and Services as more fully described in these specifications.

   2.2 "Pricing Page" means the pages, contained wvOASIS or attached hereto as **Exhibit A**, upon which Vendor should list its proposed price for the Contract Services.

   2.3 "Solicitation" means the official notice of an opportunity to supply the State with goods or services that is published by the Purchasing Division.

   2.4 "Array" means a disk array or solid-state disk (SSD), a hardware element that contains a large group of disk drives (HDDs). It may contain several disk drive trays and has an architecture which improves speed and increases data protection. The system is run via a storage controller, which coordinates activity within the unit.

   2.5 "RAID" means (Redundant Array of Inexpensive Disks or Drives, or Redundant Array of Independent Disks) is a data storage virtualization technology that combines multiple physical disk drive components into one or more logical units for the purposes of data redundancy, performance improvement, or both.

   2.6 "NAS" means a file-level (as opposed to block-level) computer data storage server connected to a computer network providing data access to a heterogeneous group of clients. NAS is specialized for serving files either by its hardware, software, or configuration. It is often manufactured as a computer appliance – a purpose-built specialized computer. NAS systems are networked appliances which contain one or more storage drives, often arranged into logical, redundant storage containers or RAID. Network-attached storage removes the responsibility of file serving from other servers on the network.

11. MISCELLANEOUS:

11.1. Contract Manager: During its performance of this Contract, Vendor must designate and maintain a primary contract manager responsible for overseeing Vendor's responsibilities under this Contract. The Contract manager must be available during normal business hours to address any customer service or other issues related to this Contract. Vendor should list its Contract manager and his or her contact information below.

Contract Manager: Sean Finch

Telephone Number: 716-473-0284 X203

Fax Number: 716-360-9627

Email Address: sdch@yahootech.com

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: AST Technologies

Authorized Signature: _____ Date: 05/13/2020

State of Co

County of Douglas, to-wit:

Taken, subscribed, and sworn to before me this 13 day of MAY, 2020.

My Commission expires 10/7/2022, 20___.

AFFIX SEAL HERE

DONALD NIBLACK
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20104032991
MY COMMISSION EXPIRES OCTOBER 7, 2022

NOTARY PUBLIC _____

Y&S technologies

Date 05/10/2020

WV DEPARTMENT OF ENVIRONMENTAL PROTECTION
Storage Area Network Hardware and Services
Guy Nisbet

Dear Guy,

Proposal

After extensive research, Y&S is proud to be partnering up with Lenovo to offer a solution that meets or exceeds the specifications requested. Lenovo storage architects have studied your RFP and propose two similar all flash arrays designed in our joint venture with NetApp. Since 2018 Lenovo and NetApp have been investing in methods to bring the NetApp architecture to market that are more affordable with better customer service. We propose two Lenovo DM5000F storage arrays, one in Charleston and one in Logan, WV. The DM5000F would be our comparative product to NetApp A220 and exceeds specifications for each of your locations with a much more affordable footprint.

- Lenovo ThinkSystem DM5000F is a unified, all flash storage system that is designed to provide performance,
- Simplicity, capacity, security, and high availability for medium enterprises. Powered by the ONTAP software,
- ThinkSystem DM5000F delivers enterprise-class storage management capabilities with a wide choice of
- Host connectivity options and enhanced data management features. The ThinkSystem DM5000F is a perfect
- Fit for a wide range of enterprise workloads, including big data and analytics, artificial intelligence,
- Engineering and design, enterprise applications, and other storage I/O-intensive applications**.**

The technical and business relationship between Lenovo and NetApp brings much value to the State of West Virginia. Highlights are:

- Significant investment by both companies.
    - Both NetApp and Lenovo have made significate investments into this partnership. This is not the typical OEM / reseller agreement. Lenovo does not just buy NetApp products and place a Lenovo badge on it. We are producing the components that make up the storage arrays in Lenovo factories and using Lenovo supply chain. Future NetApp products will be manufactured completely by Lenovo for both companies to resell.
- Joint Venture 51% Lenovo / 49% NetApp in partnership
    - Lenovo has stood up a Joint Venture facility in PRC and is currently working on next generation storage products with NetApp engineers. This is a dedicated R&D facility for building and testing future storage products

- 90% coverage of storage market with 10 new Lenovo products
    - Lenovo has selected products that cover 90% of the storage market. IDC has identified this market as growing and representing $58B/yr. worldwide, $2.25B/yr. North America.
- Lenovo warranty and support worldwide Single route to market for Lenovo / NetApp products in 163 countries.
    - Lenovo handles Level 1-2 support for problem diagnosis and hardware break fix worldwide on Lenovo Storage products. Level 3 software problem diagnosis is handled by NetApp Level 3 via direct connection to NetApp Support.

Lenovo and Y & S are excited with the opportunity to work with your team on this implementation.

Solution

Storage Device

For this solution, we are proposing **QTY 2 of the Lenovo Think System DM5000F All Flash Array MFR# 7Y41S0TL00 one for Logan site and one for Charleston site that exceed the specifications requested. Please see the full build below on what we are proposing.** I have attached Data sheets for your convenience. Please note specification are per unit.

Components	Description	Qty
7Y41S0TL00	ThinkSystem DM5000F	1
B38L	Lenovo ThinkSystem Storage 2U24 Chassis	1
B5RJ	DM Series Premium Offering	1
B39F	Lenovo ThinkSystem DM Series DM3000/DM5000 Cntr, 16Gb FC/10Gb Opt	2
B4K9	10G SW Optical iSCSI SFP+ Module 1 pack	4
B65R	Lenovo ThinkSystem 23TB (6x 3.84TB, 2.5", SSD) Drive Pack for DM5000F RAW CAPACITY 69.12 TB EFFECTIVE CAPACITY 154.18 TB which well exceeds the 100TB Requested.	3
A3RG	0.5m Passive DAC SFP+ Cable	2
AVG0	3m Green Cat6 Cable	2
ASR7	Lenovo 3m LC-LC OM3 MMF Cable	4
B4BP	Lenovo ThinkSystem Storage USB Cable, Micro-USB	1
6311	2.8m, 10A/100-250V, C13 to C14 Jumper Cord	2
B79W	Lenovo ThinkSystem DM Series ONTAP 9.6 Encryption	1
B0W1	3 Years	1
B46X	Essential Service	1
B472	Configured with Lenovo ThinkSystem DM5000F	1
AU16	0.5m External MiniSAS HD 8644/MiniSAS HD 8644 Cable	2
B38Y	Lenovo ThinkSystem Storage Rack Mount Kit 2U24/4U60	1
B4CX	Lenovo ThinkSystem DM Series 2U Accessory	1
B39L	Lenovo ThinkSystem DM Series 2U24 Bezel	1
B38Z	Lenovo ThinkSystem Storage SFF Drive Filler	6

B396	Lenovo ThinkSystem DM5000F Product Label	1
B4BG	Lenovo ThinkSystem Storage 2U24 System Label	1
B4AW	Lenovo ThinkSystem Storage Packaging 2U	1
B39C	Lenovo ThinkSystem DM Series Ship Kit (RoW)	1
B4SK	DM Series SnapMirror License	2
B4SF	DM Series CIFS Protocol License	2
B4SG	DM Series NFS Protocol License	2
B5AZ	DM Series SnapVault License	2
B7AQ	SnapMirror Synchronous	2
B4SU	TPM	2
B4SP	DM Series SnapManager License	2
B4SL	DM Series SnapRestore License	2
B4SN	DM Series Software Encryption License	2
B4SJ	DM Series FCP Protocol License	2
B4SM	DM Series FlexClone License	2
B4SH	DM Series iSCSI Protocol License	2
5PS7A18279 Warranty	Warranty PROTECTION 3Y 24x7x4 Onsite Warranty DM5000F	1
5WS7A32514 Warranty	WARRANTY 3Y 24x7x4 Onsite Warranty RAW CAPACITY 69.12 TB EFFECTIVE CAPACITY 154.18 TB	1

Warranty

Both storage devices and drives come with a 3 year 24x7x4 hour onsite response which includes unlimited technical support and less than a 30 minute telephone response.

Switches, SFP Modules and PCIE-Express Cards for

We are offering as requested.

- **QTY 2 of MFR# N3K-C3524P-XL Cisco Nexus 3524-XL Switch, 24 SFP+ - Manageable - 3 Layer Supported - Modular - Optical Fiber - 1U High - Rack-mountable ENHANCED**
- **QTY 16 of QLogic 57810 Dual Port 10Gb Direct AttachlSFP+ Gigabit PCI-Express®, Low Profile Network Adapter cards Adaptor cards PCI-Express® and LowProfile Network or equal.**
- **QTY 20 of MFR# SFP-10G-SR Cisco - SFP+ transceiver module - 10 GigE - 10GBase-SR - LC/PC multi-mode - up to 984 ft - 850 nm - for 250 Series; Catalyst Switch Module**
- **QTY 16 of SFP+ Modules for Dell servers.**

Services

For the services and migration we are providing as requested.

Network Installation and Setup

Work Scope:
We will perform physical installation and configuration of to up to 2 Cisco Nexus 3542 switches at Charleston or up to 4 Cisco Nexus 3542 switches across the Charleston and Logan locations as part of this RFQ project. We will work with the Service Requester to understand the desire network infrastructure and then apply the necessary configuration against each port use for server and storage connectivity. Lastly, we will also work with the Service Requester to understand and apply the appropriate configuration for the upstream aggregation ports on all the switches in scope.

DM replication

Work Scope:
As an add-on to the Lenovo DM deployment services, we will set up the replication feature between the two DM storage units across Charleston and Logan. We will work with the Service Requester to design the appropriate replication model that meets their business needs, their recovery time objective and recovery point objective. We will implement this replication architect on both DM storage solutions via the storage replication adapter and the Snap Miror feature base. Lastly, we will work with the Service Requester to define a small set of user case tests, such as manual failover and failback, and execute these tests on the solution to ensure both sites and storage units are production ready.

Red Hat and Xen Installations

Work Scope:
We will perform operating system/hypervisor installation (Red Hat and XenServer) and configuration for one 3-node cluster and one 2-node cluster at Charleston and another 3-node cluster at the Logan site. Where it is applicable, we will create the solution cluster and establish the high availability feature on each environment. Lastly, as a show of production readiness, we can assists the Service Requester in the deployment of virtual machines onto each cluster environment. The Service Requester will provide both installation media and licenses for all these systems, plus all servers in scope are already physically rack/stack in place, as this service only covers the software installation and configuration of the operating system and hypervisor.

Data Migration

Work Scope:
We will assists in the migration of up to 60TB of data on an EMC5300 solution to the new Lenovo DM solution at the Charleston location. File transfers will take place 24x7 and migration “switch over” to the DM takes place between Monday to Friday 6pm to 7am next day and all weekends, local time, per the requirements in the RFQ document. We will work with the Service Requester to identify the migration sequence, meaning which target

shares have which priority in terms of the transition timeframe. When each share is complete in its cut over, we will notify the Service Requester and subsequently allow access by the end users to the new share. We will also work with the Service Requester to fine tune the transfer activities so that this operation does not hinder the normal business operations of the Service Requester and at the same time, if allow, We can throttle the copy speed during non-business hours to accelerate the transfer to further quicken the completion of this migration project.

DM Deployment Services and Hardware installation

Work Scope:

Deployment of Lenovo ThinkSystem DM/DE Storage System

2.1 Lenovo ThinkSystem DM/DE Storage System:

1. Verify physical installation matches customer order.
2. Verify physical network, san, and power cabling.
3. Verify latest firmware and software levels are installed on the storage system.
4. Perform initial configuration of the storage system per customer requirements, including:

a. Initialize storage system Operating System (OS).
b. Create a management account and confirm client access.
c. Enable cluster failover (for clustered systems).
d. Create up to two (2) hosts on storage system. (CIFS, NFS, iSCSI, or FCP) (Note: Customer is responsible for any zoning or network configuration, or the installation of host attachment kits on host servers)
e. Configure a test volume and map to configured hosts.
f. Assist client with verifying connection and discovery of storage at server host.
g. Configure call home and event notification.
h. Perform basic tests on HA failover (on two or more systems if required).
i. Perform cluster-mode testing and operation (on two or more systems if required).
j. Perform system validation and document results.

5. Perform up to four (4) hours of on-site skills transfer.

a. Provide a quick tour of the Lenovo Support Site.
b. Register the system.

2.2 Lenovo Hardware Installation rack and stack

Extended Warranty

For both the storage devices and drives we are offering an optional 4 year 24x7x4 hour onsite response which includes unlimited technical support and less than a 30 minute telephone response.

Pricing

QTY	Part Number	Description	Price Each	Total Price
2	7Y41S0TL00	Lenovo ThinkSystem DM5000F Full Specification above	$97,749.00	$195,498.00
2	5PS7A18279 and 5WS7A32514	3 year 24x7x4 hour onsite response which includes unlimited technical support and less than a 30 minute telephone response.	$10,843.00	$21,686.00
2	N3K-C3524P-XL	Cisco Nexus 3524-XL Switch, 24 SFP+ - Manageable - 3 Layer Supported - Modular - Optical Fiber - 1U High - Rack-mountable ENHANCED	$6,499.00	$12,998.00
16	QLogic 57810 Dual Port 10Gb Direct AttachlSFP+ Adapter cards	QLogic 57810 Dual Port 10Gb Direct AttachlSFP+ Gigabit PCI-Express®, Low Profile Network Adapter cards Adaptor cards PCI-Express® and LowProfile Network	$350.00	$5,600.00
20	SFP-10G-SR	Cisco - SFP+ transceiver module - 10 GigE - 10GBase-SR - LC/PC multi-mode - up to 984 ft - 850 nm - for 250 Series; Catalyst Switch Module	$294.00	$5,880.00
16	SFP+ Modules for Dell servers.	SFP+ Modules for Dell servers.	$36.00	$576.00
1	Services	All Services, Migration installation, Deployment Requested.	$96,221.00	$96,221.00
				Total Price: $338,459.00

Extended Warranty Price

QTY	Part Number	Description	Price Each	Total Price
2	**4 year Warranty Option**	**Optional 4 year 24x7x4 hour onsite response which includes unlimited technical support and less than a 30 minute telephone response.**	**$3,798.00**	**$7,596.00**

Datasheets

We have provided datasheets literature of the services we are providing.

Trade References

1) **Ingram Micro.** Point of Contact is Donna Hill, Relationship Manager VAR Credit. 1759 WEHRLE DRIVE WILLIAMSVILLE, NY 14221. Donna Can be reached at Direct (716)633-3600 ext. 65005 and by email at donna.hill@ingrammicro.com

2) **TechData.** Point of Contact is Tom Grivas, Strategic Account Rep I, SMB East Region A. 16202 Bay Vista Drive Clearwater FL, 33760. Tom can be reached via email at smbea1@techdata.com

Bank References

Cory E. Parnes | Business Relationship Manager | JPMorgan Chase Bank N.A. | 59 West 86th St, New York,NY 10024 | T: 212-595-0758 | F: 855-323-5081| Cory.E.Parnes@chase.com

Insurance

Y&S Technologies maintains all required commercial insurance policies and will be more than happy to provide proof of insurance if the School District requests it.

Terms and conditions

Y&S accepts all terms and conditions of this bid.

Delivery and Services

We can provide delivery and the full services requested in 60 days ARO or less.

Y&S References

Y&S has provided solutions like this throughout the country. Here are a few references for your convenience:

1) **West Virginia Alcohol Beverage Control Administration in Charleston WV.** The point of contact is Randy Haynes who can be reached at 304-550-3967 or by Randy.L.Haynes@wv.gov. We supplied over 6 Lenovo servers in January **of 2018 worth over $50,000 we were over $30,000 dollars cheaper than the next bidder**
2) **WV OPERATIONS DIV TAX DIV REVENUE CENTER in Charleston WV.** The point of contact is George Mitchell, who can be reached at 304-558-2554 or by email George.C.Mitchell@wv.gov **we supplied 9 Lenovo servers with VMware licenses in September 2019 worth over $200,000.**
3) **Applied Materials in Hopewell Junction, NY**. Point of Contact is Paul Llanos, Ph #845-227-0298, E-mail Paul_Llanos@amat.com. **We provided Applied Materials with over $800,000 worth of System X Server equipment over the past couple of years.**
4) **Reginal Transportation Authority in Dayton, OH**. The point of Contact is Jim Canaday, who can be reached at Ph #937-425-8320 or by E-mail jcanaday@greaterdaytonrta.org. We provided 5 Lenovo System X servers with Microsoft Licenses worth over $189,000 in June 2016.
5) **Wilton Public Schools in Wilton, CT**. The point of contact is Helaine Walker, who can be reached by 203-834-4874 or by walkerh@wilton.k12.ct.us. **We sold over $575,000 worth of Lenovo storage devices with NetApp, laptops and accessories in the last 3 years.**
6) **Knoxville Utility Board in Knoxville, KY**. The point of Contact is Rebekah Taylor, who can be reached at Ph #865-558-2307 or by E-mail Rebekah.taylor@kub.org. KUB purchased over $150,000 worth of System X servers over the past couple of years.

Lenovo References

We have provided a separate page with Lenovo customer references

Point of Contact

Saul Finck (Sales Manager) will be your point of contact for this contract and will assist the State and its personnel in any matters related to this contract. Contact Information is as follows: PH #718-473-0284 Ext 200. E-mail saul@yandstech.com.

Brief History of our Company

Y&S Technologies have been in business for over twelve years with our primary focus on the education and government sector. Our senior staffs have over 40 years of combined experience, selling and servicing the academic and government market. Y & S Technologies was established in the midst of the worst recession since the Great Depression. We have not only survived but we have grown our business every year by a minimum of 20%. We offer our customers highly competitive solutions, the best products at the best prices, and a high level of service and support. These directly contribute to our successful and expanding business.

If you should need any further information please feel free to contact me at your earliest convenience. Thanking for the opportunity to do business with your city.

Saul Finck
Sales Manager
Y&S Technologies

Agreement for ThinkSystem DM/DE Deployment

This Agreement for ThinkSystem DM/DE Deployment together with any attachments, ("Agreement") is made by and between Carpenter Technology corporation, with offices located at 2 Meridian Blvd. Wyomissing, PA 19610 ("Customer"), and Lenovo Global Technology (united States a Delaware corporation, with offices at 8001 Development Drive Morrisville, NC 27560 ("Lenovo"). Customer and Lenovo may be referred to collectively in this Agreement as "parties" and individually as "party."

This Agreement becomes effective on February 1, 2019 ("Effective Date").

1.0 Scope of Services

Deployment of Lenovo ThinkSystem DM/DE Storage System

2.0 Services

2.1 Lenovo ThinkSystem DM/DE Storage System:

1. Verify physical installation matches customer order.
   a. (Note: Physical installation is not part of this scope of work but can be ordered separately).
2. Verify physical network, san, and power cabling.
3. Verify latest firmware and software levels are installed on the storage system.
4. Perform initial configuration of the storage system per customer requirements, including:
   a. Initialize storage system Operating System (OS).
   b. Create a management account and confirm client access.
   c. Enable cluster failover (for clustered systems).
   d. Create up to two (2) hosts on storage system. (CIFS, NFS, iSCSI, or FCP)
      (Note: Customer is responsible for any zoning or network configuration, or the installation of host attachment kits on host servers)
   e. Configure a test volume and map to configured hosts.
   f. Assist client with verifying connection and discovery of storage at server host.
   g. Configure call home and event notification.
      h. Perform basic tests on HA failover (on two or more systems if required).
   i. Perform cluster-mode testing and operation (on two or more systems if required).
   j. Perform system validation and document results.
5. Perform up to four (4) hours of on-site skills transfer.
   a. Provide a quick tour of the Lenovo Support Site.
   b. Register the system.

2.2 Services do not include:

1. Physical installation (racking/stacking) and cabling of storage system(s).
2. Assistance with customer or third party applications not identified in this Agreement.
3. Product defect resolution, problem determination or troubleshooting unless otherwise specified.
4. Assistance with implementation of backup/recovery and disaster recovery environment, including remote data replication services.
5. Assistance with Customer documentation, processes and standard operating procedures.
6. Any training or training sessions.
7. Any items not specifically described in Section 2.1.

3.0 Roles and Responsibilities

3.1 Customer Responsibilities

Customer shall:

1. designate a project manager who will be Customer Point of Contact for all communications related to the Services and will have the authority to act on Customer behalf in all matters regarding this Agreement. The Customer Point of Contact will provide a list of the key technical contacts with telephone and email contact information prior to the start of Services.

2. provide an on-site contact during normal business hours at each location with access to the buildings/rooms where Services will be performed and any necessary security. Additional charges may apply for work outside normal business hours. If necessary, Customer shall provide afterhours access to Customer facilities.
3. provide a safe environment and full unrestricted access to all locations where Services is to be performed. Services will be performed at the Customer premises, except for any project, related activity that Lenovo determines would be best performed remotely on Lenovo premises in order to complete its obligations and responsibilities under this Agreement.
4. safeguard Customer data (including but not limited to confidential information, password protection, encryption, data backup, etc.) prior to Services by Lenovo. In no event shall Lenovo assume any risk or liability for data loss or data breach.
5. promptly obtain and provide to Lenovo all Required Consents necessary for Lenovo to provide Services described in this Agreement. A Required Consent means any consents or approvals required from Customer to give Lenovo and its subcontractors the right or license to access the locations where the Services are to be performed and to access, use and/or modify (including creating derivative works) the hardware, software, firmware and other products, without infringing the ownership or license rights (including patent and copyright) of the providers or owners of such products. Lenovo shall be excused from its performance obligations in the event that Customer fails to promptly provide any Required Consents.
6. provide an installation schedule and requirements prior to Services Provider arriving onsite.
7. troubleshoot all network connectivity problems to resolve general and network connectivity issues.
8. be responsible for all hardware and software compatibility issues.
9. customizing or provide the settings for user preferences.
10. provide a script for the install, if applicable.
11. be responsible for any zoning or network configuration, or the installation of host attachment kits on host servers

3.2 Lenovo Responsibilities

Lenovo shall:

1. designate a primary contact that will be the Customer focal point for all communications related to this Services and will have the authority to act on behalf of Lenovo in all matters regarding this Agreement; and
2. provide Services at Customers location during normal business hours, 8:30 AM to 5:30 PM, local time, Monday through Friday, except holidays.

4.0 Change Control Procedure

If either party desires to change Services, they shall utilize a Project Change Request Form (“PCR”), in the form attached hereto as Attachment A, to initiate the change process. Acts or omissions of Customer that impact schedule or scope may result in additional charges. Lenovo shall notify Customer of any such acts or omissions and the resulting increase in charges. Such changes shall be as agreed on a PCR. The scope or schedule of Services may only be changed by a completed Attachment A signed by an authorized representative of each party. In no event shall Lenovo be required to implement any change to Services until an amendment has been signed as described in this section.

4.1 Change Management Process:

1. The party proposing the change will document the request using the PCR Form.
2. The receiving party will review the proposed Project Change Request and determine whether the change is acceptable or requires modifications.
3. Both parties will, in good faith, mutually review the proposed Project Change Request and will (i) approve it, (ii) agree to further investigation, or (iii) reject it.
4. When the parties agree to the change, they will sign the PCR Form, which upon signing by both parties shall be deemed an amendment to this SOW authorizing implementation.

5.0 Lenovo Business Partners

Lenovo may contract with suppliers, distributors and resellers (“Business Partners”) to promote, market, and support certain Services. Business Partners are independent from Lenovo. Lenovo is not responsible for the actions or statements of Business Partners, any obligations that they may have to Customer; or any products or services that they supply to Customer. When Customer purchases Services from Business Partners, Business Partners establish the prices for the Services as well as the applicable terms.

6.0 Prices

The prices for the Services described in this Agreement are exclusive of applicable taxes and are provided on a firm fixed price basis as set forth in the following table.

Services Description	Ordering Part Number	Quantity
ThinkSystem DM Deployment	5MS7A24102	1

Services performed under this Agreement will be invoiced on a monthly basis unless otherwise agreed.

6.1 Payment terms

The prices of the Services provided under this Agreement shall be as stated in Section 6.0.

All amounts are due upon receipt of invoice. Any amounts not received by Lenovo within thirty (30) days of receipt of invoice shall be overdue. Customer shall pay a late payment fee of the lesser of one and one half (1.5%) percent per month or the maximum rate permitted by law on the undisputed overdue balance of the invoice amount.

Customer shall pay any applicable sales, use or similar taxes, fees or duties unless Customer provides exemption documentation to Lenovo. Customer is responsible for taxes, if any, from the date on which Services are provided by Lenovo.

7.0 Project Management

Services shall be performed consistent with the scheduling process and mutually agreed volumes, timelines. Any special considerations may be identified in attachments to this Agreement. Both parties agree to make reasonable efforts to carry out their respective responsibilities according to any agreed schedules.

Should any Services be identified as a significant project effort then the parties may establish a project plan to manage the effort. Any special rates or considerations that apply to projects shall be addressed using the Change Control process.

8.0 Completion Criteria

Lenovo shall notify Customer when Services are complete. Customer shall have three (3) business days from receipt of such notice to report any deficiencies in writing to Lenovo. Customer's failure to provide notice of deficiencies within such period shall be deemed acceptance by the Customer.

9.0 Term and Termination

1. Lenovo may terminate this Agreement upon thirty (30) days' prior written notice.
2. Either party may terminate this Agreement if the other party fails to comply with any material terms, provided the party alleged not to be in compliance is provided with written notice and a reasonable time to comply.
3. Customer agrees to pay Lenovo for:
   a. all Services Lenovo provides and any intellectual property Lenovo delivers through Agreement termination date;
   b. all expenses Lenovo incurs through Agreement termination date; and
   c. any charges Lenovo incurs in terminating the Agreement.
4. Any terms of this Agreement which by their nature extend beyond Agreement termination, shall remain in effect and apply to both party's successors and assignees.

10.0 Limited Warranty

10.1 Lenovo warrants Services will be performed in a workmanlike manner consistent with the terms of this Agreement.

TO THE EXTENT PERMITTED UNDER APPLICABLE LAW, THIS WARRANTY IS EXCLUSIVE AND REPLACES ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND ANY WARRANTY OR CONDITION OF NON-INFRINGEMENT. ALL SOFTWARE, AND THIRD PARTY PRODUCTS ARE PROVIDED "AS IS", WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND. THIRD PARTY MANUFACTURERS, SUPPLIERS, LICENSORS OR PUBLISHERS MAY PROVIDE THEIR OWN WARRANTIES.

Lenovo does not warrant uninterrupted or error-free operation of a Service or that Lenovo will correct all defects.

11.0 Limitation of Liability

11.1 In any action arising out of or related to Services, this Agreement or any order issued hereunder, neither party nor its affiliates, shall be liable to the other party or its affiliates for any of the following even if informed of their possibility and whether arising in contract, tort, (including negligence) or otherwise: (a) third-party claims for damages; (b) loss of, or damage to, data; (c) special, incidental, indirect, punitive, exemplary or consequential damages; or (d) lost profits, business, revenue, goodwill or anticipated savings.

11.2 The total liability of either party and its affiliates to the other party and its affiliates for all actions arising out of or related to Services, this Agreement or any order issued hereunder, regardless of the form of the action or the theory of recovery, shall be limited to the price paid or payable by Customer or its affiliate under the applicable order for such Services.

11.3 The limits in Section 11.2 also apply to any of Lenovo's subcontractors, suppliers and program developers. It is the maximum for which Lenovo and its subcontractors, suppliers and program developers are collectively responsible.

11.4 The provisions of Sections 11.1 and 11.2 shall not apply to: (i) damages for bodily injury (including death); (ii) damage to real property or tangible personal property; or (iii) a party's indemnification obligations.

12.0 General

1. This Agreement does not apply to any hardware or software product(s) that may be related to the Services
2. Lenovo reserves the right to subcontract Services, or any part of them, to subcontractors selected by Lenovo.
3. Each party is responsible for the supervision, direction, control, and compensation of its personnel.
4. Each party may communicate with the other by electronic means and such communication is acceptable as a signed writing to the extent permissible under applicable law. An identification code (called a "user ID") contained in an electronic document is legally sufficient to verify the sender's identity and the document's authenticity.
5. Any open source software that may be delivered in association with the Services is licensed and distributed to Customer by the open source software distributors and/or respective copyright and other rights holders ("Right Holders") under the Right Holders' terms and conditions. Lenovo is neither a party to the Right Holders' license nor a distributor of the open source software and is performing the Services on Customer's behalf and based upon your specifications. Lenovo does not provide any express or implied patent license or other license with respect to such open source. Lenovo uses open source software "AS IS" and makes no representations or warranties, either express or implied, with respect to open source software. Lenovo shall not be liable for any damages arising out of Customers use or distribution of open source software.
6. Each party is free to enter into similar agreements with other parties.
7. Each party grants the other party only the license and rights specified in any applicable license agreements. No other licenses or rights (including licenses or rights under patents) are granted either directly, by implication, or otherwise.
8. Customer shall not resell the Services. Any attempt to do so is void unless agreed in writing by Lenovo.
9. Neither party may bring a legal action, regardless of form, arising out of or related to this Agreement more than two years after the cause of action arose unless otherwise required by applicable local law. After such period, any legal action arising out of this Agreement or the transaction under it and all respective rights related to any such action shall lapse, unless otherwise required by applicable law without the possibility of contractual waiver or limitation.
10. Neither party is responsible for failure to fulfil any obligations due to causes beyond its control.
11. Neither party grants the other the right to use its (or any of its enterprise's) trademarks, trade names, or other designations in any promotion or publication without prior written consent.
12. In the event that any provision of this Agreement is held to be invalid or unenforceable, the remaining provisions of this Agreement remain in full force and effect.

13. Lenovo and its affiliates may store, use and process contact information and other information about Customer, including names, phone numbers, addresses, and e-mail addresses, necessary to perform under this Agreement. Such information will be processed and used in connection with our business relationship, may be transferred by Lenovo to any country where Lenovo does business and may be provided to entities acting on our behalf in relation to this Agreement. Lenovo may also disclose such information where required by law.
14. Each party shall comply with any laws and regulations that are applicable to this Agreement.
15. Customer may not assign this Agreement, in whole or in part, without the prior written consent of Lenovo. Any attempt to do so is void.
16. Governing Law: This Agreement shall be governed by and interpreted in accordance with the laws of North Carolina, without regard to its or any other jurisdiction's conflict of laws principles. All claims or disputes arising out of or in connection with this Agreement shall be brought exclusively in a court located in Wake County, North Carolina. To that end, each party irrevocably consents to the exclusive jurisdiction of, and venue in, any such court, and waives any: (i) objection it may have to any proceedings brought in any such court; (ii) claim that the proceedings have been brought in an inconvenient forum; and (iii) right to object (with respect to such proceedings) that such court does not have jurisdiction over such party. Without limiting the generality of the forgoing, each party specifically and irrevocably consents to personal and subject matter jurisdiction for such claims or disputes in a court sitting in Wake County, North Carolina, and to the service of process in connection with any such claim or dispute by the mailing thereof by registered or certified mail, postage prepaid to such party, at the address set forth in, or designated pursuant to, this Agreement. The United Nations Convention on Contracts for the International Sale of Goods shall not apply.
17. Nothing in this Agreement shall affect any statutory rights of consumers that cannot be waived or limited by contract.
18. The rights, duties, and obligations of each party are valid only in the country of purchase except that all licenses are valid as specifically granted. Unless otherwise expressly stated, the laws of the country in which Customer purchased the Service govern this Agreement. To the fullest extent permitted by law, each party hereby expressly waives (on behalf of itself and on behalf of any person or entity claiming through such party) any right to a trial by jury in any action, suit, proceeding, or counterclaim of any kind arising out of or in any manner connected with this Agreement or the subject matter hereof.
19. Except for payment obligations, neither party shall be liable to the other for any failure or delay in the performance of its obligations, to the extent such failure or delay is caused by fire, flood, earthquakes, other elements of nature; acts of war; terrorism, riots, civil disorders, rebellions or revolutions; epidemics, communication line or power failures; governmental laws, court orders or regulations; or any other cause beyond its reasonable control.
20. Any terms of this Agreement, which by their nature survive the expiration, termination or cancellation of this Agreement, including but not limited to Section 11.0 shall survive the expiration or termination of this Agreement.
21. This Agreement is the sole and complete understanding of the parties regarding the subject matter hereof, superseding all prior or contemporaneous agreements and understandings, whether written or oral.
22. Additional Services may become subject to this Agreement only when added by an amendment signed by both parties. Any additional or different terms not in a writing signed by both parties and any contrary terms on a Customer purchase order shall not be a part of this Agreement.
23. This Agreement may be executed in counterparts, all of which together shall constitute one and the same instrument.
24. The following Attachments are incorporated herein and made part of the Agreement

    Attachment A: Project Change Request Form

25. All notices which a party may provide to the other concerning this Agreement shall be in writing by means of e-mail with receipt confirmed, facsimile, certified or registered mail, express mail, other overnight delivery, or hand delivery with proper postage or other charges paid and addressed directed to the parties as follows. Such notice will be deemed received when actually received or seventy-two (72) hours after being sent as specified above, whichever occurs first:

Agreement for ThinkSystem DM/DE Deployment

To: Carpenter Technology Corporation Customer address: Attn: Tel: Fax: E-mail:	To: Lenovo Global Technology (United States) Attn: Kathy O´Neil Tel 919 294 2862 Fax 919 294 4987 E-mail address: kaoneil@lenovo.com

---

IN WITNESS WHEREOF, each party has caused this Agreement to be signed by its authorized representative.

Carpenter Technology Corporation	**Lenovo Global Technology (United States)**
By _____ Authorized Signature	 By Authorized Signature
Name:	Name: Ryan Bradley
Date:	Date: February 01, 2019

Agreement for ThinkSystem DM/DE Deployment

Attachment A

Project Change Request (PCR) Form

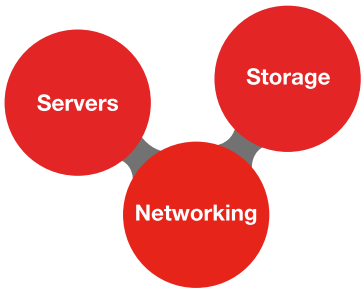
GENERAL INFORMATION			
PCR Number:		Revision Number:	
Create Date:		Revision Date:	
PCR Title:			
Agreement/SOW Title			
Customer or Vendor Name:	Name:	Email:	Phone:
Change Initiator: *(prepared by)*	Name:	Email:	Phone:

SCOPE OF CHANGE			
Reason for Change:	*(Include description of existing state)*		
Description of Desired Change:			
Effect of Change:	*(Include description of impact if implemented and if NOT implemented)*		
	In the fields below, identify impact to Budget, Schedule, Quality, Quantity, Resources, and Cost ; insert n/a if not applicable		
	Budget:	Schedule:	Quality:
	Quantity:	Resources:	Cost:
	Cost to be paid by:		

SIGNATURE			
Upon signatures by both parties the Agreement or SOW identified above shall be amended as described herein.			
For Lenovo		For <INSERT CUSTOMER/VENDOR NAME>	
Signature		Signature:	
Printed Name:		Printed Name	
Title:		Title:	
Date:		Date:	

Technology Services | Implementation Services | Solution Services

APPLICABLE FOR THE HIGHLIGHTED CATEGORIES



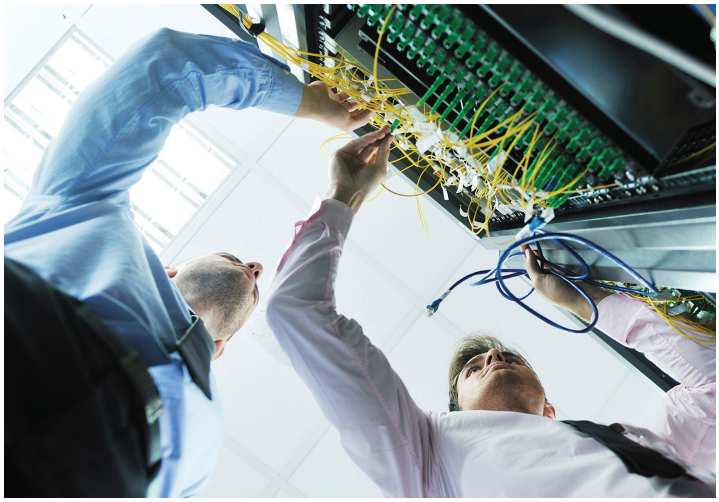
● = Available (some exclusions apply)

LENOVO SERVICES℠

HARDWARE INSTALLATION

Efficient and smooth installation by experts

BENEFITS



EFFICIENT

Keep your IT staff focused on higher priorities

CONVENIENT

Arrange the service to fit your schedule

SEAMLESS

Let experienced technicians perform the installation

SENSIBLE

Avoid wasted time and extra expense with a preinstallation checklist

Lenovo experts can seamlessly manage the physical installation of your server, storage, or networking hardware so you can quickly benefit from your investment. Working at a time convenient for you, the technician will unpack and inspect the systems on your site, install them, verify operation, and dispose of the packaging, allowing your team to focus on other priorities. Your new systems will be configured and ready for your software installation. It's the most efficient way to quickly get your investment working for you, with minimal disruption to your staff.

Any Lenovo-branded server, storage, or networking devices, as well as select Lenovo-supported products from other vendors that are sold by Lenovo or a Lenovo-authorized reseller, are eligible for Lenovo Hardware Installation Services. Customized installation services are also available to meet your specific needs.

INSTALLATION PROCESS

PREINSTALLATION

Our team of professionals has extensive knowledge and the experience to help ensure the installation goes smoothly. With your help, the technician will arrive well prepared and complete the task with minimal disruption to you and your staff. A preinstall checklist will serve as your guide to ensure you've completed all hardware preparations and the hardware can be installed with ease. These steps include:

- Backing up data you need to migrate to the new hardware
- Ensuring the new hardware is available and in place
- Providing a power supply, network connection, racks, cables, and any other necessary parts
- Designating a representative who is available and able to assist the technician with access, approvals, IP addresses, and so on
- Providing a safe workspace and appropriate access for the technician

When you're ready, we'll schedule a call with you to review the checklist, answer any questions about the process, and schedule a convenient time to install the hardware.

INSTALLATION

You can rely on the expert to provide end-to-end installation, including:

- Initial removal of the product from packaging, including inspection for damage
- Installation of the product per the associated documentation
- Physical connection and powering on of hardware
- Firmware and BIOS check and update to the latest levels if needed
- Consolidation of all packaging materials and disposal within your site
- Installation of Lenovo-branded or Lenovo-supported devices into the rack

OPERATIONAL VERIFICATION

All systems will be thoroughly tested to ensure full operation. Your new hardware will be ready for your software installation.

LIMITATIONS

This service is designed for systems to be used in business settings, but there are a few limitations, including:

- Service coverage—contact your local services representative to determine if your site location falls within the covered area
- Troubleshooting and solutions for problems encountered during installation, unless covered by Lenovo warranty or Lenovo support agreement
- Data center design or reconfiguration
- Reconfiguration of manufacturer-configured solutions
- Installation of software products or data
- Connectivity to the network, except as required to install firmware
- Wide area network (WAN) and local area network (LAN) troubleshooting
- Moving hardware to the installation location
- Any services not clearly specified in this document

CUSTOMERS WHO BOUGHT THIS OFFERING ALSO PURCHASED

Technology Services

Protect your technology investment with services that support all of your operational requirements.

Implementation Services

Let the Lenovo experts deploy your equipment and keep it running so you can focus on the business.

Solution Services

Tackle your most complex challenges with help from Lenovo Services professionals experienced in technology solutions.

Lenovo™ offers a comprehensive portfolio of services that support the full lifecycle of your Lenovo IT assets. At every stage of planning, deployment, and support, we offer the expertise and services you need to more accurately budget for IT expenses, deliver better service-level agreements, and generate greater end-user satisfaction. Let Lenovo Services' unique offerings and expertise help you get the most out of your technology investment.

Lenovo Services

Lenovo Hardware Installation Services are part of a comprehensive portfolio of Lenovo Services that support the entire suite of enterprise products. For more information, contact your Lenovo representative or visit WWW.LENOVO.COM

Lenovo Partial Customers – Reference Available

Ohio State University

Marshall University

West Virginia University

Michigan State University

Indiana University

Northern Michigan University

Notre Dame University

State of Indiana

State of West Virginia

State of Ohio

State of Kentucky

State of South Carolina

State of North Carolina

State of Virginia

Corporate Fact Sheet

We are Lenovo

Lenovo is a US$50 billion Fortune Global 500 company, with 57,000 employees and serving customers in 180 markets around the world.

Focused on a bold vision to deliver smarter technology for all, we are developing world-changing technologies that create a more inclusive, trustworthy and sustainable digital society. By designing, engineering and building the world's most complete portfolio of smart devices and infrastructure, we are also leading an Intelligent Transformation – to create better experiences and opportunities for millions of customers around the world.

At Lenovo, we manufacture one of the world's widest portfolios of connected products, including PCs (ThinkPad, Yoga, Lenovo Legion), tablets, smartphones and workstations as well as augmented and virtual reality (Mirage, ThinkReality) and smart home/office solutions, software and services. Lenovo's data center solutions (ThinkSystem, ThinkAgile) are creating the capacity and computing power for the connections that are changing business and society.

Lenovo's new innovations are built for Intelligent Transformation, the idea of people improving their lives through the use of transformative technology – for play, work, or in the home. Challenging the status quo and rethinking form factors and user experiences have resulted in numerous technology breakthroughs in the past fiscal year, notably and most recently the announcement of the world's first PC with a foldable screen in May. In 2019, our innovations received a total of 75 awards at the Consumer Electronics Show (CES) and 24 awards at Mobile World Congress (MWC).

"At a time of great global change—economically, socially and environmentally—we continue to focus on how we 'intelligently transform' ourselves and enable our many customers around the world successfully to do the same."

—Yang Yuanqing,
Lenovo Chairman and CEO

Lenovo's manufacturing business model leverages a mix of both company-owned manufacturing capabilities as well as original design manufacturers (ODM). This hybrid model is a significant source of competitive advantage, helping bring new innovations to market more efficiently whilst ensuring greater control over both product development and supply chain operations. Our facilities are located in Japan, the U.S., Mexico, India, Brazil, Germany, Hungary and multiple locations in China.

Lenovo's financial headquarters is located in Hong Kong, with key operations centers in Beijing and Morrisville, North Carolina.

Shares of Lenovo are listed on the Stock Exchange of Hong Kong (HKSE stock code: 0992) and are available in the form of ADR shares (ADR: LNVGY).

A customer centric, multi-business company

With a globally balanced footprint across 180 markets and diversified businesses, Lenovo is well positioned to lead in and enable Intelligent Transformation, positioning the company for the next wave of strong, sustainable growth.

At Lenovo, we have two product business groups. The Intelligent Devices Group (IDG) encompasses the PC and Smart Devices business, including PCs, tablets, augmented and virtual reality (AR/VR), smart devices, software and services, and the Mobile business for smartphones. The second group is the Data Center Business Group (DCG), which includes servers, storage, networking, software and services. The company is supported by the Lenovo Capital and Incubator Group (LCIG) which drives innovation through investments and incubation in startups that align to the company's Intelligent Transformation strategy.

Intelligent Devices Group

PC and Smart Devices business
Through customer innovation, Lenovo is the #1 PC company in the world (according to IDC) with record market share of 23.4% for the past fiscal year and remains the fastest growing PC company among the top five players. We combine investment in high-growth segments (workstations, gaming, visuals, thin and light devices) with new innovation in the burgeoning smart device categories, enabling our global technology leadership position to thrive as our PC business strengthens. The business continues to deliver on its Intelligent Transformation vision in enabling smarter technology for all with recent innovations such as the world's first foldable PC, world's first 5G PC, ThinkBook series, Lenovo Smart Clock, Lenovo Smart Display, Lenovo Smart Tabs and ThinkSmart Hub. Built based on customer feedback and insights, these new technologies create more intuitive and immersive user experiences to improve lives.

In addition, we continue to explore new opportunities across AR/VR, artificial intelligence (AI), Internet of Things (IoT), security and as-a-service solutions.

Mobile business
Our mobile business under IDG became profitable starting from the second half of the year FY2018/19. This notable achievement came from masterful execution on Lenovo's strategy to a clear focus on selected markets, a competitive product portfolio and expense control. The Mobile Business Group (MBG) continues to gain new ground globally as it challenges industry convention and defines a new era of mobile innovation. Most recently, the company launched the world's first 5G upgradeable phone, the moto Z[3].

Data Center Group

The Lenovo's Data Center Group remains #1 in the world in performance with 139 world records, #1 in x86 reliability and customer satisfaction, and the #1 provider of supercomputers in the TOP500 list. Fueled by continued investments in the future, people and technology, the Data Center business continues transformation to a complete portfolio data center organization as it drives the future of Smart Infrastructure from edge to cloud. Lenovo's ThinkSystem and ThinkAgile solution portfolios as well as Lenovo TruScale Infrastructure Services, create the capacity and computing power for the connections that are changing business and society.

Lenovo Capital and Incubator Group

A significant component of our innovation focus is The Lenovo Capital and Incubator Group (LCIG). The LCIG develops new technologies through strategic global incubation and investments in five key areas of the Smart Internet value chain: IOT + Edge Computing + Cloud + Big Data + Artificial Intelligence, and drive it to integrate deeply with vertical industries and Lenovo ecosystem.

FY2018/19 Q4 Performance

(For the fiscal quarter ended March 31, 2019)

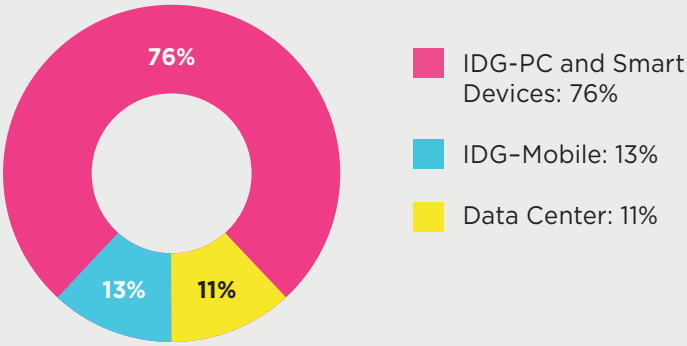
Lenovo showed strong momentum in the 4th quarter, closing out FY18/19 as Lenovo's best year yet, with record revenue delivering on its Intelligent Transformation strategy and highlighting its leadership across all segments.

"Over the last four years, Lenovo has been on a journey to build a customer centric, multi-business company that can thrive in the transforming world. We have built many new capabilities along the way. Now, our multi-business operational system is in place and the new foundation of the company has been built. I can proudly say that this is the most promising time in Lenovo's history", said Yang Yuanqing, Lenovo Chairman and CEO.

- Highest annual revenue surpassing US$50 billion, setting a new record at US$51 billion – up 12.5% year-on-year
- Intelligent Transformation strategy drives full year pre-tax income jump to US$856 million – up more than four times at 459% year-on-year
- Full year net income is US$597 million, an increase of US$786 million from last fiscal year
- Strong Q4 performance with group revenue reached US$11.7billion – up 10.1% year-on-year
- Q4 revenue and profit up across all businesses for the first time since x86 and Motorola acquisitions, and improved profitability: PTI at US$180 million, up 389% year-on-year; net income up 261% year-on-year to US$118 million
- Major milestones hit across all businesses:
  - PC and Smart Devices business revenue record for the year of US$38.5 billion and PTI of US$1.98 billion, and continues to be global #1 PC company with record market share of 23.4% in the past fiscal year and remains the fastest growing among the top five global players.
  - Mobile Business Group improved PTI by more than US$464 million year-to-year—becoming profitable during the second half of the fiscal year, Prioritized regions saw rapid growth, including a record share of 17.6% in Latin America. In North America, volume outgrew the market by 59.2 points and in China by 185.8 points premium to market.
  - The Data Center Group achieved the fastest year-on-year growth since the acquisition of the x86 server business, growing 37% with record full year revenue of US$6.02 billion. This was led by strong growth of the Hyperscale and Software Defined Infrastructure, which had revenue growth of 240% and 96% year-on-year respectively.

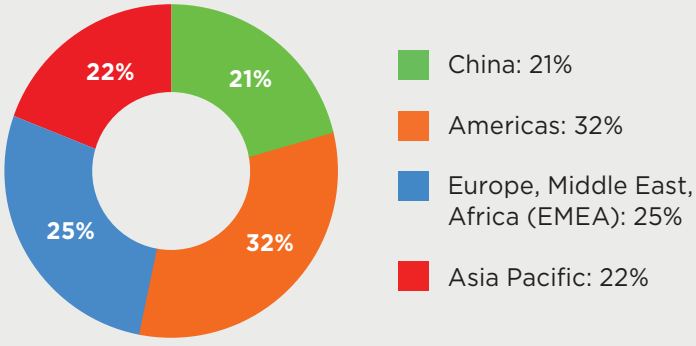
Revenue by Business Group

FY2018/19 Q4



Revenue by Geography

FY2018/19 Q4



The next chapter: Bringing smarter technology to all

As we look to the future our vision is to bring smarter technology to all—through Smart IoT, Smart Infrastructure and Smart Verticals. This is the next chapter in the Lenovo story —where we see our greatest opportunity for future growth and industry leadership.

- **Smart IoT**—this is the touchpoint for the connected world we live in. Firstly, it's about making current devices smarter—always connected, easy to collaborate with other devices, adaptive to a customer's needs, seamlessly connecting to the cloud etc.—like Lenovo's Smart Clock, Smart Camera and Smart Lock. This always on/always connected view of the world has unlimited potential meaning ordering a pizza through a speaker or unlocking a door with "a look" is a reality. Beyond that it's about embedding smart computing power into hundreds of devices that are not yet smart—homes, factories, hospitals and much more.

- **Smart Infrastructure**—this foundation provides the computing, storage and networking power to support intelligent devices. The number of smart devices worldwide will reach 20 billion by 2020, more than double the number in 2017, which in turn means data is doubling in volume every two years. It's this infrastructure engine that powers public cloud companies, high-performance computing for scientific computing and AI companies and is the backbone of every organization today.

- **Smart Verticals**—the combination of big data harnessed from smart devices and the computing power of smart infrastructure is already seeing Lenovo create models that provide insights for customers that can dramatically improve business processes, decision-making and financial return—ultimately solving tangible business problems. As a result, we are transforming industries that have not yet been able to realize the benefits of what technology can bring.

Lenovo ThinkSystem DM Series Performance Guide

Introduces DM Series performance concepts

Explains ONTAP performance fundamentals

Explains controller reads and writes operations

Provides basic infrastructure check points

Vincent Kao

LENOVO PRESS

Abstract

Lenovo® ThinkSystem™ DM Series Storage Arrays run ONTAP data management software, which gives customers unified storage across block-and-file workloads. This document covers the performance principles of the ONTAP operating system and the best practice recommendations.

This paper is intended for technical specialists, sales specialists, sales engineers, and IT architects who want to learn more about the performance tuning of the ThinkSystem DM Series storage array. It is recommended that users have basic ONTAP operation knowledge.

At Lenovo Press, we bring together experts to produce technical publications around topics of importance to you, providing information and best practices for using Lenovo products and solutions to solve IT challenges.

See a list of our most recent publications at the Lenovo Press web site:

http://lenovopress.com

Do you have the latest version? We update our papers from time to time, so check whether you have the latest version of this document by clicking the **Check for Updates** button on the front page of the PDF. Pressing this button will take you to a web page that will tell you if you are reading the latest version of the document and give you a link to the latest if needed. While you're there, you can also sign up to get notified via email whenever we make an update.

Contents

Introduction

Lenovo ThinkSystem DM Series Storage Arrays are unified storage systems that are designed to provide performance, simplicity, capacity, security, and high availability for businesses of any size. Powered by the ONTAP software, ThinkSystem DM Series Storage Arrays deliver hybrid and all-flash storage with enterprise-class storage management capabilities and a wide choice of host connectivity options, flexible drive configurations, and enhanced data management features.

Figure 1 Lenovo ThinkSystem DM5000H

For more information about ThinkSystem DM Series Storage, see the Lenovo Press product guide:

https://lenovopress.com/lp0941-lenovo-thinksystem-dm-series-unified-storage-arrays

ONTAP software introduction

ONTAP software unifies data management across flash, disk, and cloud to simplify your storage environment. It bridges current enterprise workloads and new emerging applications. It builds the foundation for a Data Fabric, making it easy to move your data where it is needed across flash, disk, and cloud resources.

For complete ONTAP documents, see ThinkSystem storage online help:

https://thinksystem.lenovofiles.com/help/index.jsp?topic=%2Fcom.lenovo.thinksystem.storage.doc%2Foverview_storage.html

Aggregates and RAID groups

Modern RAID technologies protect against disk failure by rebuilding a failed disk's data on a spare disk. The system compares index information on a “parity disk” with data on the remaining healthy disks to reconstruct the missing data, all without downtime or a significant performance cost.

An aggregate consists of one or more RAID groups. The RAID type of the aggregate determines the number of parity disks in the RAID group and the number of simultaneous disk failures the RAID configuration protects against.

The default RAID type, RAID-DP (RAID-double parity), requires two parity disks per RAID group and protects against data loss in the event of two disks failing at the same time. For RAID-DP, the recommended RAID group size is between 12 and 20 HDDs and between 20 and 28 SSDs.

You can spread out the overhead cost of parity disks by creating RAID groups at the higher end of the sizing recommendation. This is especially the case for SSDs, which are much more reliable than capacity drives. For HDD aggregates, you should balance the need to maximize disk storage against countervailing factors like the longer rebuild time required for larger drive size in the RAID groups.

RAID protection levels for disks

ONTAP supports three levels of RAID protection for aggregates. Your level of RAID protection determines the number of parity disks available for data recovery in the event of disk failures.

With RAID protection, if there is a data disk failure in a RAID group, ONTAP can replace the failed disk with a spare disk and use parity data to reconstruct the data of the failed disk.

- RAID4: With RAID4 protection, ONTAP can use one spare disk to replace and reconstruct the data from one failed disk within the RAID group. RAID4 option is only available through CLI.
- RAID-DP: With RAID-DP protection, ONTAP can use up to two spare disks to replace and reconstruct the data from up to two simultaneously failed disks within the RAID group.
- RAID-TEC: With RAID-TEC protection, ONTAP can use up to three spare disks to replace and reconstruct the data from up to three simultaneously failed disks within the RAID group.

Default RAID policies for aggregates

Either RAID-DP or RAID-TEC is the default RAID policy for all new aggregates. The RAID policy determines the parity protection you have in the event of a disk failure.

RAID-DP provides double-parity protection in the event of a single or double disk failure. RAID-DP is the default RAID policy for the following aggregate types:

- All flash aggregates
- Flash Pool aggregates
- Enterprise hard disk drive (HDD) aggregates

RAID-TEC is supported on all disk types and all platforms, including all-flash arrays. Aggregates that contain larger disks have a higher possibility of concurrent disk failures. RAID-TEC helps to mitigate this risk by providing triple-parity protection so that your data can survive up to three simultaneous disk failures. RAID-TEC is the default RAID policy for capacity HDD aggregates with disks that are 6 TB or larger.

Considerations for sizing RAID groups

Configuring an optimum RAID group size requires a trade-off of factors. You must decide which factors—speed of RAID rebuild, assurance against risk of data loss due to drive failure, optimizing I/O performance, and maximizing data storage space—are most important for the aggregate that you are configuring.

When you create larger RAID groups, you maximize the space available for data storage for the same amount of storage used for parity (also known as the “parity tax”). When a larger disk fails in a RAID group, reconstruction time is increased, impacting performance for a longer period of time. In addition, having more disks in a RAID group increases the probability of a multiple disk failure within the same RAID group.

HDD or array LUN RAID groups

You should follow these guidelines when sizing your RAID groups composed of HDDs or array LUNs:

- All RAID groups in an aggregate should have a similar number of disks.

  The RAID groups do not have to be exactly the same size, but you should avoid having any RAID group that is less than one half the size of other RAID groups in the same aggregate when possible.

- The recommended range of RAID group size is between 12 and 20.

  The reliability of enterprise hard disk drives can support a RAID group size of up to 28, if needed.

- If you can satisfy the first two guidelines with multiple RAID group sizes, you should choose the larger size.

SSD RAID groups in Flash Pool aggregates

The SSD RAID group size can be different from the RAID group size for the HDD RAID groups in a Flash Pool aggregate. Usually, you should ensure that you have only one SSD RAID group for a Flash Pool aggregate, to minimize the number of SSDs required for parity.

SSD RAID groups in SSD aggregates

You should follow these guidelines when sizing your RAID groups composed of SSDs:

- All RAID groups in an aggregate should have a similar number of drives.

  The RAID groups do not have to be exactly the same size, but you should avoid having any RAID group that is less than one half the size of other RAID groups in the same aggregate when possible.

- For RAID-DP, the recommended range of RAID group size is between 20 and 28.

Introduction to ONTAP performance

The fundamental unit of work performed by storage systems is a *data operation* (typically shortened to simply *op*) that either reads or writes data to or from storage systems. There are other types of operations, especially in NFS and CIFS/SMB environments, operations such as creation/deletion of files and directories, lookups, and get and set attributes. Our discussion focuses primarily on read and write ops.

The complexities surrounding performance come from the many variables that affect performance. In addition, there are many different types of derived measurements describing performance called metrics. Among these metrics, two are considered most significant and believed to accurately characterize performance at its highest level:

- Throughput
- Latency

The first, throughput, describes the amount of work the system is doing by expressing units of work over time: for example, megabytes per second (MBps) or input/output operations per second (IOPS). The second, latency, describes the time it takes to complete a unit of work: for example, a user read or write operation expressed in milliseconds per operation (ms/op) units.

On all-flash arrays, latency is expressed in microseconds per operation, due to flash's very much higher performance. Note that the term latency in the context of this document is

functionally equivalent to round trip response time. This terminology, though technically questionable, is a long-standing tradition in the storage industry and would be prohibitive to change. Tens of thousands or hundreds of thousands of operations take place every second, so throughput and latency are typically expressed as averages normalized over a given time range (for example, per second) and a unit of work (for example, per operation).

The ONTAP operating system and the underlying cluster hardware work efficiently to make sure data is secure, reliable, and always available. Collectively, the operations mix generated by applications is uniquely referred to as an *application set workload*, often shortened to simply *workload*.

Workload characteristics that can affect and be used to describe performance include:

- Throughput. The number of operations or amount of data payload over a given period.
- Concurrency. The number of operations in flight (or resident) at a given point in time.
- Operation size. The size of the operations requested. The data portion of the operation often referred to as block size or payload.
- Operation type. The type of operation requested of the storage system (for example, read, write).
- Randomness. The distribution of data access across a dataset in an unpredictable pattern.
- Sequentiality. The distribution of data access across a dataset in a repeatable pattern. Many patterns can be detected: forward, backward, skip counts, and others.
- Working set size. The amount of data considered to be active and frequently used to complete work.
- Dataset size. The amount of data that exists in a system that is both active and at rest.

Varying any of these workload characteristics ultimately ends up affecting the performance of the system and can be observed through measured changes in either latency or throughput. In many production environments, application workload almost always increases over time, often without warning. Therefore, the performance of the storage system must be known.

With this knowledge, plans to allocate more resources or rebalance workloads can be made to meet the demands placed upon the system.

Performance relationships

There are some guiding principles behind performance that can be useful in day-to-day operations. These can be stated as relationships between the fundamental characteristics of a workload and their impact on performance:

- Throughput is a function of latency.
- Latency is a function of throughput.
- Latency is a function of service times and wait times. Wait times make up most the time and are a function of utilization, which is a function of load.
- Throughput is a function of concurrency, operation size, and randomness of operations or access patterns.
- Host applications control the operation mix, operation size, randomness, and concurrency.

These relationships can be summarized by an exponential growth curve as depicted in Figure 2, where response time (or latency) increases nonlinearly as utilization (or throughput) increases.

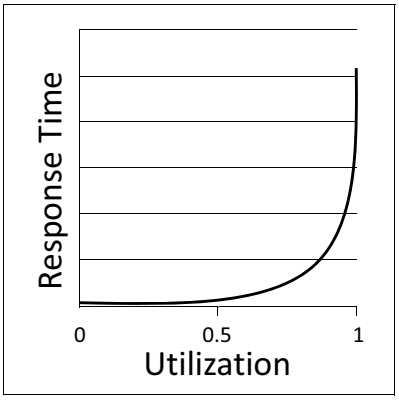


Figure 2 Response time exponential growth curve as utilization is saturated

Throughput and latency

Workloads can be defined as either closed-loop or open-loop systems. In closed-loop systems, a feedback loop exists. Subsequent operation requests from applications are dependent upon the completion of previous operations and, when bounded by the number of concurrent operation requests, limit the offered load. In this scenario, the number of concurrent requests is fixed, and the rate that operations are completed depends on how long it takes (latency) for previous operations to be completed. The SQL database access is an example of closed-loop systems. Simply put, in closed-loop systems, throughput is a function of latency; if latency increases, throughput decreases. Latency tends to be more fixed, and increasing concurrency increases throughput. Imagine the video streaming services. Single video stream is another example of closed-loop systems, since the frame sequence is fixed.

In open-loop systems, operations are performed without relying on feedback from previous operations. This configuration can be a single enterprise-class application generating multiple asynchronous requests or hundreds of independently running servers issuing a single threaded request, e.g. multiple concurrent VMware instances. This fact means that the response time from those operations doesn't affect when other operations are requested. The requests occur when necessary from the application. As offered load to the system increases, the utilization of the resources increases. As the resource utilization increases, so does operation latency. Because of this utilization increase, we can say that latency is a function of throughput in open-loop systems, although indirectly. Imagine the video streaming services, again. Multiple concurrent video stream requests from various users are considered open-loop systems.

Concurrency

Storage systems are designed to handle many operations at the same time. In fact, peak efficiency of the system can never be reached until it is processing a large enough number of operations such that there is always one waiting to be processed behind another process. Concurrency, the number of outstanding operations in flight at the same time, allows the storage system to handle the workload in the most efficient manner. The effect can be dramatic in terms of throughput results.

Concurrency is the number of parallel operations that can be performed at the same time. It is another way of describing parallelism. Most storage arrays are designed to process many

operations in parallel and are typically at their most efficient when processing multiple threads concurrently as opposed to a single operation at a time. One way to understand concurrency is to consider how much more work can be handled in each unit of time if multiple streams of work can be worked at the same time instead of having a single stream with a rather long queue. Consider a line of 10 people waiting to pay for items at a store. If a single cashier is open, then the cashier performs a total of 10 checkouts to clear the line and performs those one after the other. If instead 5 cashiers are open, then the queue for each averages 2 transactions, and all 10 complete much more rapidly, even though each individual transaction takes the same amount of time as in the single-cashier example.

Little's Law: A relationship of throughput, latency, and concurrency

Little's Law describes the observed relationship between throughput (arrival rate), latency (residence time), and concurrency (residents):

$L = A \times W$

This equation says that the concurrency of the system (L) is equal to the throughput (A) multiplied by the latency (W). This implies that for higher throughput, either concurrency would have to increase and/or latency would have to decrease. This explains why low-concurrency workloads (single-threaded workloads), even with low latencies, can have lower than expected throughput. Thus, to increase throughput with low latency requires more workloads to be added to the environment or more concurrency added to the workload.

Operation size

A similar effect on concurrency is observed with the size of operations on a system. More work, when measured in megabytes per second (MBps), can be done with larger operations than can be done with smaller operations. Each operation has fixed overhead associated with it. When the operation size (or data payload) is increased, the ratio of overhead to data is decreased, which allows more throughput over the same time. Similarly, when work depends on latency in low-concurrency workloads, a larger operation size increases the data throughput efficiency of each individual operation.

Small operations might have a slightly better latency than large operations, so the operations per second could be potentially higher, but the measured data throughput suffers with smaller operations.

Data access (random or sequential)

Data operations sent to a storage system access a logical location within a data file or LUN. This logical location is ultimately translated into an actual physical location on the permanent storage media. The order of operations and the access pattern of the data over time determine the randomness of a workload. When the logical addresses are ordered (next to one another), access patterns are considered sequential.

Sequentially read data exhibits better performance characteristics because fewer drive seeks and operations are required from permanent storage media. Solid-state drives (SSDs) exhibit a much lower impact from random access than spinning media. ONTAP is highly write-optimized. Due to the way writes are written to storage, almost all writes behave as if they are sequential writes. Thus, we see less improvement in random versus sequential writes.

Cluster-node system architecture overview

Storage systems are designed to store and retrieve large amounts of data reliably, inexpensively, and quickly. It is important to recognize that every workload interacts with the system differently, and there are many different workloads. This fact creates a technical challenge around providing the best performance for workload conditions that are largely unknown. Lenovo meets this challenge through innovative technologies combining the use of spinning disk, flash, and RAM.

A Lenovo storage system may be logically divided into three main areas when discussing performance. Those are connectivity, the system itself, and the storage subsystem. Connectivity refers to the network interface card (NIC) and host bus adapter (HBA) that attach the storage system to the clients and hosts. The system itself is the combination of CPU, memory, and NVRAM. Finally, the storage subsystem consists of the disks and Flash Cache and Flash Pool intelligent caching. Figure 3 logically represents a Lenovo hard disk or hybrid system.

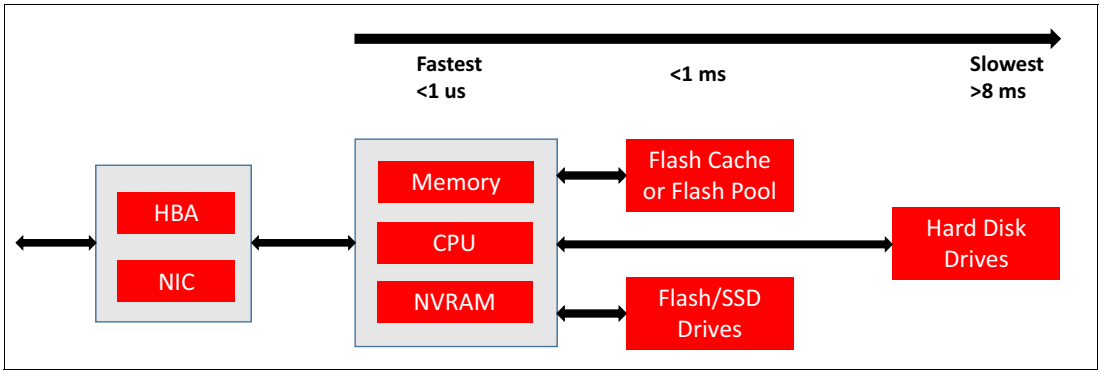


Figure 3 High-level traditional HDD or hybrid cluster node system architecture

Compare the traditional HDD or hybrid system with a Lenovo all-flash array (AFA), which is depicted in Figure 4. Notice that no spinning media are present, and there is no need for Flash Cache or Flash Pool because primary storage is very fast flash.

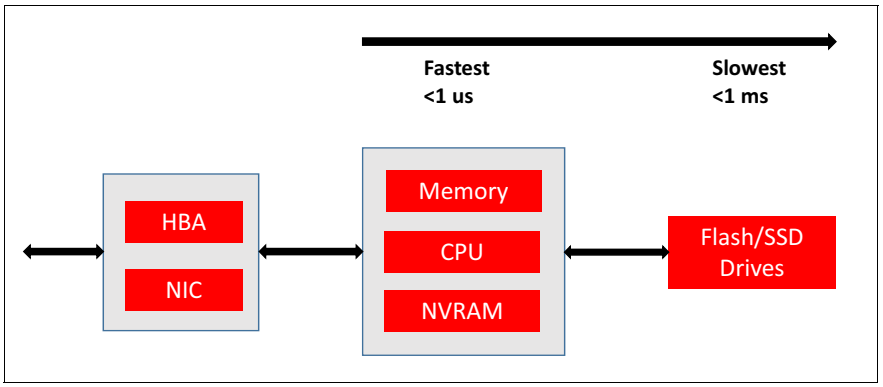


Figure 4 High-level flash/SSD node system architecture

A system running ONTAP consists of individual nodes joined together by the cluster interconnect. Every node in the cluster can store data on disks attached to it, essentially adding “copies” of the preceding architecture to the overall cluster. ONTAP has the capability to non-disruptively add additional nodes to the system to scale both system performance and capacity. An ONTAP cluster can scale both vertically and horizontally to meet the needs of the customer’s application environment.

Connectivity: NICs and HBAs

NICs and HBAs provide the connectivity to client, management, and cluster interconnect networks. Adding more or increasing the speed of NICs or HBAs can scale client network bandwidth.

Controller subsystem: memory, CPU, and NVRAM

The number of CPU cores and the amount of memory vary based on controller model. As with any computer, the CPU provides the processing power to complete operations for the system. In addition to holding the ONTAP operating system, the memory in a DM Series controller also acts as a cache. Incoming writes are staged in main memory prior to being written to disk. Memory is also used as a read cache to provide extremely fast access time to recently read data.

DM Series arrays also contain NVRAM. NVRAM is battery-backed memory used to protect inbound writes as they arrive. This fact allows write operations to be safely acknowledged without having to wait for a disk operation to complete, greatly reducing write latency. High-availability (HA) pairs are formed by mirroring NVRAM across two controllers. By staging writes in memory and NVRAM and then committing them to disk during a consistency point (CP), DM Series can both acknowledge writes very quickly and make almost all writes appear to be sequential. This is because at a CP the storage controller optimizes all the writes stored in memory and writes long stripes to disk.

Increasing the capacity and performance of these components requires either upgrading to a higher performance controller model or upgrading the version of ONTAP software running on your controllers. ONTAP software upgrades typically include performance boosts where continuous code optimizations provide performance boosts that can be quite dramatic.

Storage subsystem: Disks, Flash Cache, and Flash Pool

Spinning disk drives are the slowest persistent storage media available and have traditionally been the bottleneck in storage performance. The typical response times for spinning disks range from 3ms to 5ms for 10,000RPM and 7200RPM drives, respectively. Solid-state disks are generally an order of magnitude faster and both significantly reduce the latency at the storage subsystem and change the nature of performance tuning and sizing. Ultimately, the type of disk needed for a specific application depends on capacity, performance requirements, and workload characteristics.

Generally, when sizing or tuning a storage system design to optimize performance with spinning disks, high-performance designs call for maximizing the number of drive spindles being used to spread I/O across large numbers of disks. This allows the storage array being configured to parallelize I/O across large numbers of disks. In addition to maximizing the number of disks in the array, the other principal method of increasing performance is to add faster media, either RAM or SSDs, to act as an intermediate cache holding hot data so that repeated access can be served from cache rather than requiring much more latency-intensive disk operations.

Flash Cache and Flash Pool technology leverage the performance of solid-state flash technology with the capacity of spinning media. Flash Cache typically operates as an additional layer of read cache for the entire system. It caches recently read, or “hot,” data for future reads. Flash Pool serves as a read cache in a fashion similar to that of Flash Cache at the aggregate level as opposed to the system level. This fact allows improved cache

provisioning for specific workloads. Flash Pool also caches random overwrites, improving write latency as well.

The wide availability and rapidly falling prices of SSDs have changed this paradigm. Now when designing, sizing, or tuning high-performance arrays, you would choose an all-flash array. Performance requirements can now be satisfied by SSDs and therefore rarely rely on additional RAM or caches to store hot data because the typical SSD is an order of magnitude more highly performing than even the fastest 10k spinning disks. The other side effect of the huge speed increases with SSDs is that it's no longer required to spread high-performance workloads across a large number of spindles to achieve very high performance required. We now frequently see 40 to 50 spindles collapsed to a couple of SSDs that can support the IOPS requirements that might have taken 40 to 50 HDDs, even when the space provided by all those drives wasn't necessary. Of course, rapid increases in SSD capacities are also leaving HDDs behind.

With the advent of all-flash arrays, all storage is flash, and therefore main storage is an order of magnitude more highly performing. It doesn't require similar caching strategies and moves the performance bottleneck from the SSDs themselves to the controller and CPU.

Data storage and retrieval

The fundamental purpose of a storage system is to provide services to access data reliably (without error), persistently (always available), securely, and quickly. A DM Series does this through presenting storage abstractions, such as volumes, LUNs, and file systems, that are physically hosted on a pool of resources referred to as a cluster. Clusters are composed of individual nodes connected through a back-end cluster interconnect network. Every node is an autonomous system managing its dedicated resources running technologically advanced software that flawlessly orchestrates these services called ONTAP.

DM Series read operations

Read operations can be serviced from memory, flash-based cache, or disk (which may be either spinning or flash-based drives). The workload characteristics and capabilities of the system determine where reads are serviced and how quickly. Knowing where reads are serviced can help set expectations as to the overall performance of the system. In the following diagrams, components and links in red highlight the activity described.

In the slowest case (Figure 5), read requests that are not cached anywhere must come from disk. After being read from disk, the data is kept in main memory.

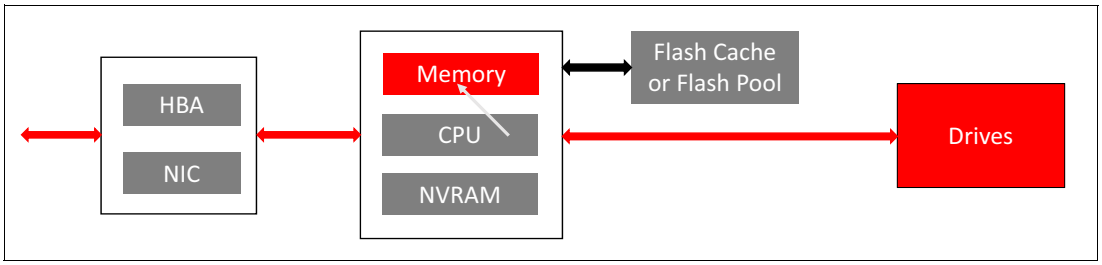


Figure 5 Read from disk

If this data is read again soon, it is possible for the data to still be cached in main memory, making subsequent access extremely fast because no disk access would be required (Figure 6).

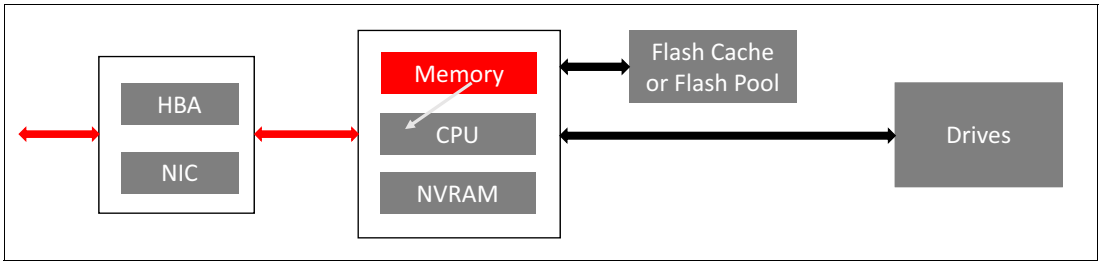


Figure 6 Read from memory

When more room is needed in the main memory cache, as is common with working sets larger than the memory cache, data is evicted. If Flash Cache or Flash Pool is in the system, that block could be inserted into the flash-based cache. In general, only randomly read data and metadata are inserted into flash-based caches (Figure 7).

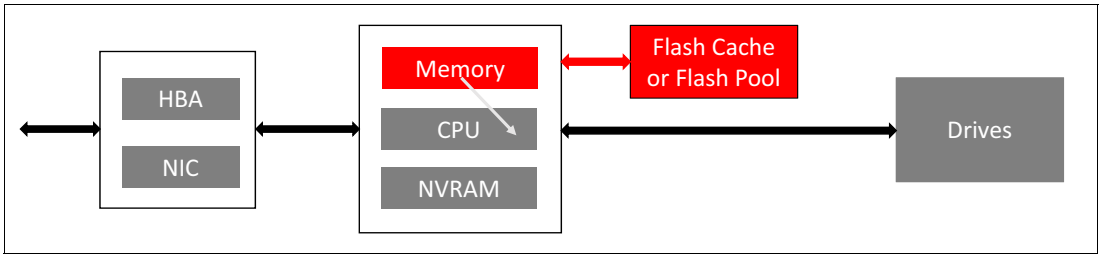


Figure 7 Write to flash

After data is inserted into Flash Cache, subsequent reads of this block unable to be serviced from the memory cache would be served from the flash-based cache (Figure 8) until they are evicted from the flash-based cache. Flash access times are significantly faster than those of disk, and adding cache in random read-intensive workloads can reduce read latency dramatically. Of course, on all-flash arrays the access times from the drives are greatly reduced. Flash arrays generally don't use intermediate Flash Cache because they don't tend to accelerate access over the already very fast flash drives being used for storage.

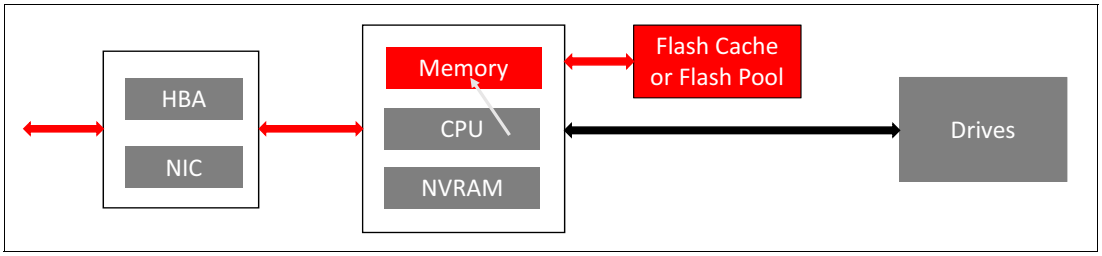


Figure 8 Read from flash

Incoming reads are continually being checked for access patterns. For some data access patterns, such as sequential access, ONTAP predicts which blocks a client might want to access prior to the client ever requesting. This "read-ahead" mechanism preemptively reads blocks off disk and caches them in main memory. These read operations are serviced at faster RAM speeds instead of waiting for disk when the read request is received. Even with vastly faster flash drives, data residing in a memory cache is still faster than going to the disk for the same data.

DM Series write operations

For most storage systems, writes must be placed into a persistent and stable location prior to acknowledging to the client or host that the write was successful. Waiting for the storage system to write an operation to disk for every write could introduce significant latency. To solve this problem, DM Series systems use battery-backed RAM to create nonvolatile RAM (NVRAM) to log incoming writes.

NVRAM is divided in half, and only one half is used at a time to log incoming writes. When controllers are in highly available pairs, half of the NVRAM is used to mirror the remote partner node's log, while the other half is used for logging local writes. The part that is used for logging locally is still split in half, just like a single node as shown in Figure 9.

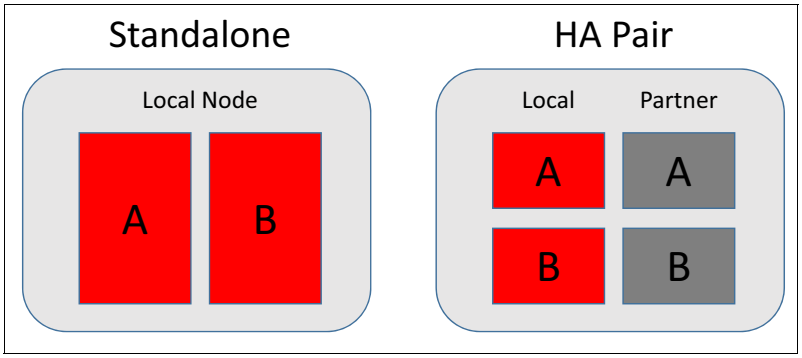


Figure 9 NVRAM segmenting: standalone and HA pair

When a write enters a DM Series, the write is logged into NVRAM and is buffered in main memory. After the data is logged in persistent NVRAM, the write is acknowledged to the client (Figure 10). NVRAM is accessed only in the event of a failure.

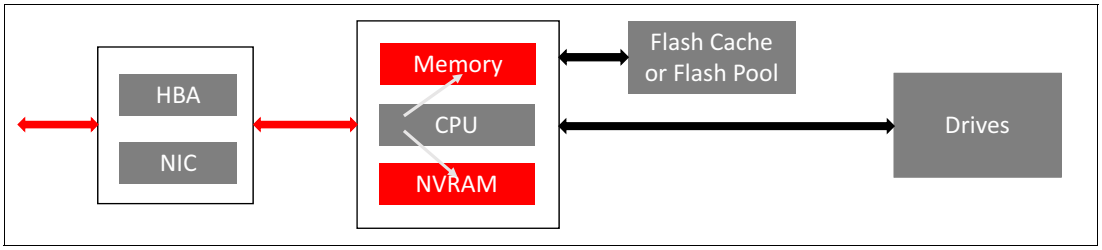


Figure 10 Accepting a write

At a later point in time, called a consistency point (CP), the data buffered in main memory is efficiently striped to disk (Figure 11). CPs can be triggered for several reasons, including time passage, NVRAM utilization, or system-triggered events such as a Snapshot copy.

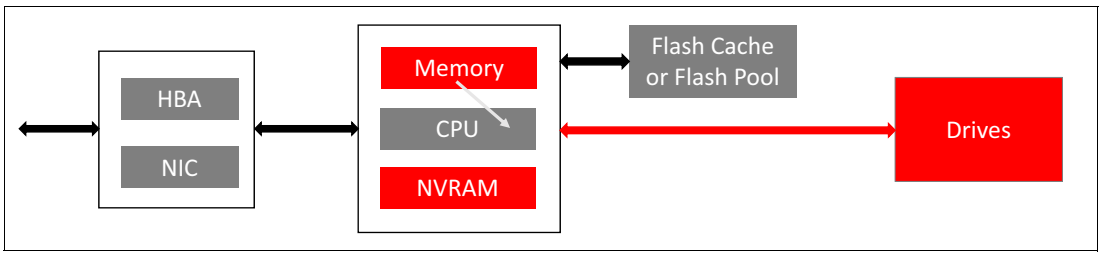


Figure 11 Consistency point

In general, writes take a minimal amount of time, on the order of low milliseconds to sub-milliseconds. If the disk subsystem is unable to keep up with the client workload and becomes too busy, write latency can begin to increase.

When writes arrive too quickly for the provisioned back-end storage, both sides of the NVRAM can fill up and lead to a scenario called a *back-to-back CP*. This fact means that both segments of NVRAM log are full, a CP is currently occurring, and another CP immediately follows the current CP's completion. This scenario affects performance because the system can't immediately acknowledge the write because NVRAM is full, and the client must wait until the operation can be logged.

Improving the storage subsystem often alleviates the back-to-back CP scenario. Increasing the number of disks, moving some of the workloads to other nodes, and considering flash-based caching or adding flash-based drives can help solve write performance issues.

The per-aggregate consistency points (PACPs), which can also reduce the incidence of back-to-back CPs because rather than having a single global CP that is ultimately only as fast as the slowest (and/or busiest) disk subsystem, the PACPs occur on a per-aggregate basis and therefore are performed on like disk types.

Performing basic infrastructure checks

Some basic diagnostic checks of your infrastructure will help you rule out obvious sources of performance problems. You should review protocol and network settings and check disk throughput and latency. If you are replicating data, you will want to monitor throughput and latency between nodes.

For the complete section in Performance Management Power Guide, see ThinkSystem Documentation Information Center:

https://thinksystem.lenovofiles.com/help/topic/performance_management_power_guide/9E17B1E2-EDE7-4CE6-BE7A-52D331E672A2_.html

The content is also available as a PDF:

https://thinksystem.lenovofiles.com/help/topic/performance_management_power_guide/M_E368AB74-F212-44B7-B18F-83FA7725CC7F_.pdf

For more information about ThinkSystem DM Series Storage, see the Lenovo Press product guide:

https://lenovopress.com/lp0941-lenovo-thinksystem-dm-series-unified-storage-arrays

Author

Vincent Kao is a Performance Engineer on the Lenovo Storage Development Team, based in Taipei. He is responsible for the performance analysis of RAID storage systems. Vincent earned a Master's Degree in Electrical Engineering from San Jose State University, CA and a Bachelor's Degree in Electrical Engineering from National Central University, Taiwan.

Thanks to the following people for their contributions to this project:

- Ted Vojnovich, CTO External Storage
- Yuwen Yang, Storage Development
- Shawn Andrews, Storage Development
- David Watts, Lenovo Press

Notices

Lenovo may not offer the products, services, or features discussed in this document in all countries. Consult your local Lenovo representative for information on the products and services currently available in your area. Any reference to a Lenovo product, program, or service is not intended to state or imply that only that Lenovo product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any Lenovo intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any other product, program, or service.

Lenovo may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

Lenovo (United States), Inc.
1009 Think Place - Building One
Morrisville, NC 27560
U.S.A.
Attention: Lenovo Director of Licensing

LENOVO PROVIDES THIS PUBLICATION “AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some jurisdictions do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. Lenovo may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

The products described in this document are not intended for use in implantation or other life support applications where malfunction may result in injury or death to persons. The information contained in this document does not affect or change Lenovo product specifications or warranties. Nothing in this document shall operate as an express or implied license or indemnity under the intellectual property rights of Lenovo or third parties. All information contained in this document was obtained in specific environments and is presented as an illustration. The result obtained in other operating environments may vary.

Lenovo may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Any references in this publication to non-Lenovo Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this Lenovo product, and use of those Web sites is at your own risk.

Any performance data contained herein was determined in a controlled environment. Therefore, the result obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

This document was created or updated on January 17, 2020.

Send us your comments via the **Rate & Provide Feedback** form found at
http://lenovopress.com/lp1276

Trademarks

Lenovo and the Lenovo logo are trademarks or registered trademarks of Lenovo in the United States, other countries, or both. These and other Lenovo trademarked terms are marked on their first occurrence in this information with the appropriate symbol (® or ™), indicating US registered or common law trademarks owned by Lenovo at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of Lenovo trademarks is available from https://www.lenovo.com/us/en/legal/copytrade/.

The following terms are trademarks of Lenovo in the United States, other countries, or both:

Lenovo® Lenovo(logo)® ThinkSystem™

The following terms are trademarks of other companies:

Other company, product, or service names may be trademarks or service marks of others.

Lenovo ThinkSystem DM5000F Unified Flash Storage Array

Product Guide

Lenovo ThinkSystem DM5000F is a unified, all flash storage system that is designed to provide performance, simplicity, capacity, security, and high availability for medium enterprises. Powered by the ONTAP software, ThinkSystem DM5000F delivers enterprise-class storage management capabilities with a wide choice of host connectivity options and enhanced data management features. The ThinkSystem DM5000F is a perfect fit for a wide range of enterprise workloads, including big data and analytics, artificial intelligence, engineering and design, enterprise applications, and other storage I/O-intensive applications.

ThinkSystem DM5000F models are 2U rack-mount controller enclosures that include two controllers, 64 GB RAM and 8 GB battery-backed NVRAM (32 GB RAM and 4 GB NVRAM per controller), and 24 SFF hot-swap drive bays (2U24 form factor). Controllers provide universal 1/10 GbE NAS/iSCSI or 8/16 Gb Fibre Channel (FC) ports, or 1/10 GbE RJ-45 ports for host connectivity.

A single ThinkSystem DM5000F Storage Array scales up to 144 solid-state drives (SSDs) with the attachment of Lenovo ThinkSystem DM240S 2U24 SFF Expansion Enclosures.

Figure 1. Lenovo ThinkSystem DM5000F

Up to 12 DM5000F Storage Arrays can be combined into a clustered system in a NAS environment, or up to 6 DM5000F Storage Arrays can be combined into a clustered system in a SAN environment.

Did you know?

A single ThinkSystem DM5000F scales up to 2.2 PB of raw storage capacity. A cluster of the DM5000F storage systems scales up to 26.5 PB for NAS or up to 13.2 PB for SAN environments.

The ThinkSystem DM5000F offers unified file and block storage connectivity with support for 1 GbE or 10 GbE NAS and iSCSI, and 8 Gb or 16 Gb Fibre Channel protocols at the same time.

Key features

The ThinkSystem DM5000F offers the following key features and benefits:

- All-flash array capabilities to meet the demand for higher speed storage and provide higher IOPs and bandwidth with lower power usage and total cost of ownership than hybrid or HDD-based solutions.
- Unified, all flash storage with dual active/active controller configurations for high availability and performance.
- Improved performance and data protection with RAID-DP and RAID-TEC, as well as support for traditional RAID 4.
- Flexible host connectivity to match diverse client needs with support for unified NAS and SAN storage protocols, including 1/10 GbE NAS and iSCSI, and 8/16 Gb Fibre Channel connectivity.
- 12 Gb SAS drive-side connectivity with multipathing with up to 24x 2.5-inch small form factor (SFF) drives in the 2U24 SFF enclosures.
- Scalability to up to 144 SFF drives with the attachment of the ThinkSystem DM240S 2U24 SFF expansion enclosures to satisfy growing needs for storage capacity and performance.
- A rich set of standard storage management functions available at no extra cost, including snapshots, volume copy, quality of service, thin provisioning, compression, deduplication, encryption, disk-based backup, application- and virtual machine-aware backup, quick data recovery, clustering, synchronous replication, and asynchronous replication.
- Optional licensed functions, including WORM (write once, read many) data protection (SnapLock) and object storage tiering (FabricPool).
- Scale-out clustering of up to 12 ThinkSystem DM Series storage systems for NAS connectivity or up to six DM Series storage systems for SAN connectivity.
- Intuitive, web-based GUI for easy system setup and management.
- Lenovo XClarity support for centralized systems management of Lenovo x86 servers, switches, and storage, which provides automated agent-less discovery, inventory, monitoring, and additional platform-specific functions across multiple systems.
- Designed for 99.9999% availability with redundant hot-swap components, including controllers and I/O modules, power supplies, and non-disruptive firmware upgrades.
- Certified Enterprise Storage for SAP HANA Tailored Data center Integration (TDI).
- Certified storage for Oracle VM.
- Certified storage for Citrix XenServer: http://hcl.xenserver.org/storage/910/Lenovo_DM_Series.

The ThinkSystem DM5000F supports the 2.5-inch 960 GB, 3.84 TB, 7.68 TB, and 15.36 TB capacity-optimized SAS SSDs. All drives are dual-port and hot-swappable.

The ThinkSystem DM5000F supports attachment of up to five ThinkSystem DM240S 2U24 SFF expansion enclosures. More drives and expansion enclosures are designed to be dynamically added with virtually no downtime, which helps to quickly and seamlessly respond to ever-growing capacity demands.

The ThinkSystem DM5000F offers high levels of system and data availability with the following technologies:

- Dual-active controllers (high availability pair) with automatic load balancing and failover
- Mirrored, battery-backed controller NVRAM
- Dual-port SAS SSDs with automatic drive failure detection and rebuild
- Redundant, hot-swappable and customer replaceable hardware components, including SFP+ transceivers, controllers, I/O modules, power supplies, and drives
- Automated failover for the data path between the host and the drives with multipathing
- Non-disruptive controller and drive firmware upgrades
- Scale-out clustering

Components and connectors

The following figure shows the front of the ThinkSystem DM5000F or DM240S 2U SFF enclosure.

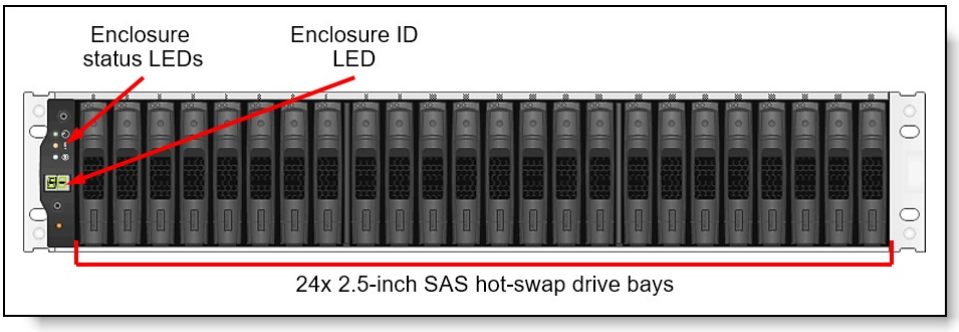


Figure 2. ThinkSystem DM5000F or DM240S enclosure front view

The front of the ThinkSystem DM5000F or DM240S 2U SFF enclosure includes the following components:

- 24 SFF hot-swap drive bays.
- Enclosure status LEDs.
- Enclosure ID LED.

The following figure shows the rear of the ThinkSystem DM5000F 2U controller enclosure with universal SFP+ host ports.

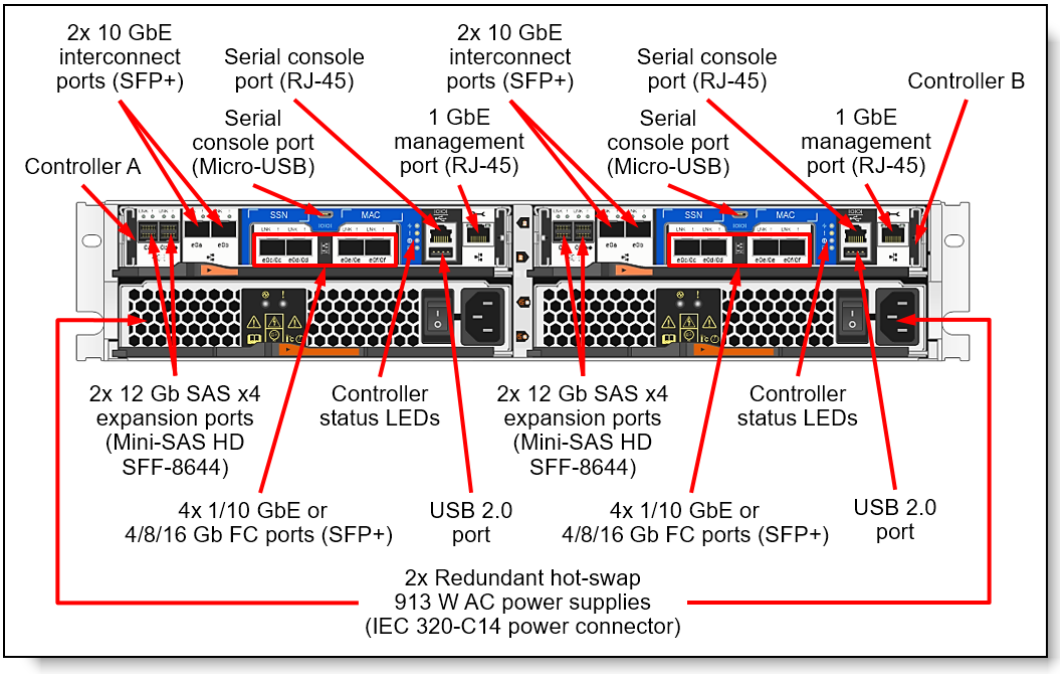


Figure 3. ThinkSystem DM5000F 2U controller enclosure rear view: Universal SFP+ host ports

The following figure shows the rear of the ThinkSystem DM5000F 2U controller enclosure with 10GBASE-T host ports.

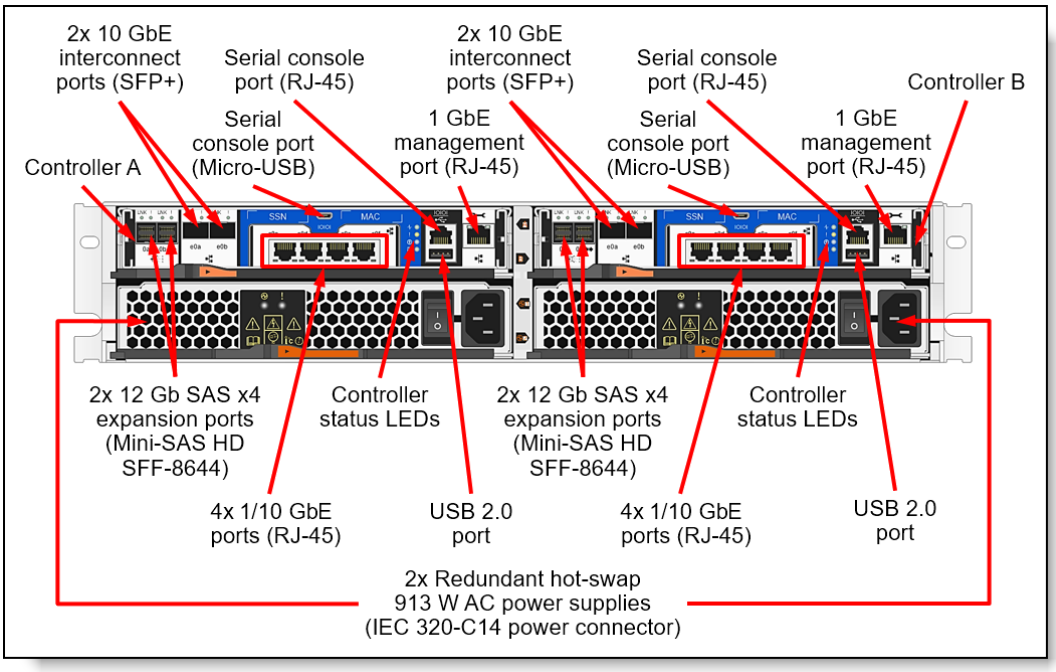


Figure 4. ThinkSystem DM5000F 2U controller enclosure rear view: 10GBASE-T host ports

The rear of the ThinkSystem DM5000F 2U controller enclosure includes the following components:

- Two redundant hot-swap controllers, each with the following ports:
  - Two SFP+ interconnect ports for direct-attach HA pair or switched cluster connections.
  - Four SFP+ host ports for 1/10 Gb GbE or 4/8/16 Gb FC connectivity, or four 1/10 GbE RJ-45 ports.
  - Two 12 Gb SAS x4 ports (Mini-SAS HD SFF-8644) for connections to the expansion enclosures.
  - One RJ-45 10/100/1000 Mb Ethernet port for out-of-band management.
  - Two serial console ports (RJ-45 and Micro-USB) for another means to configure the system.
  - One USB Type A port (for ONTAP software installation or booting)
- Two redundant hot-swap 913 W (100 - 240 V) AC power supplies (IEC 320-C14 power connector) with integrated cooling fans.
- Controller status LEDs.

The following figure shows the rear of the ThinkSystem DM240S 2U expansion enclosure.

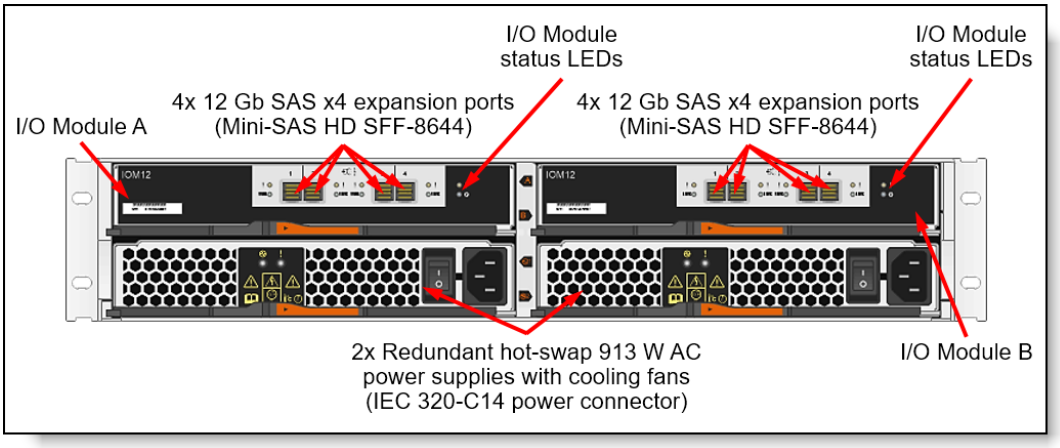


Figure 5. ThinkSystem DM240S 2U expansion enclosure rear view

The rear of the ThinkSystem DM240S 2U expansion enclosure includes the following components:

- Two redundant hot-swap I/O Modules; each I/O Module provides four 12 Gb SAS x4 expansion ports (Mini-SAS HD SFF-8644) for connections to the controller enclosures and for connecting the expansion enclosures between each other.
- Two redundant hot-swap 913 W (100 - 240 V) AC power supplies (IEC 320-C14 power connector) with integrated cooling fans.
- I/O Module status LEDs.

System specifications

The following table lists the ThinkSystem DM5000F storage system specifications.

Note: The supported hardware options and software features listed in this product guide are based on the ONTAP software version 9.6. For details about specific software releases that introduced support for certain hardware options and software features, refer to the Release notes of the particular software release for the ThinkSystem DM5000F that can be found at:
http://datacentersupport.lenovo.com

Table 1. ThinkSystem DM5000F system specifications

Attribute	Specification
Form factor	• DM5000F controller enclosure (Machine Type 7Y41): 2U rack mount. • DM240S 2U24 SFF expansion enclosure (Machine Type 7Y58): 2U rack mount.
Controller configuration	Dual active-active controller configuration (HA pair). Up to 6 HA pairs can be combined into a single SAN cluster, or up to 12 HA pairs can be combined into a single NAS cluster.
HA pair/cluster interconnect ports	4x 10 GbE SFP+ ports (DAC cables or SW fiber optics [LC]) (2 ports per controller).
RAID levels	RAID-4, RAID-DP, RAID-TEC.
Controller memory	64 GB RAM per system (32 GB per controller). 8 GB battery-backed NVRAM per system (4 GB per controller) mirrored between the controllers.
Drive bays	Up to 144 SFF hot-swap drive bays (1x 2U24 controller enclosure + up to 5x 2U24 SFF expansion enclosures).
Drive technology	12 Gb SAS SSDs.

Attribute	Specification
Drive expansion connectivity	• 2x 12 Gb SAS x4 (Mini-SAS HD SFF-8644) expansion ports on each of two controllers in the controller enclosure for the attachment of the expansion enclosures. • 4x 12 Gb SAS x4 (Mini-SAS HD SFF-8644) expansion ports on each of two I/O modules in the expansion enclosure for the attachment to the controller enclosure and daisy chaining of the expansion enclosures.
Drives	960 GB, 3.84 TB, 7.68 TB, and 15.36 TB SAS SSDs (1 DWD).
Storage capacity	Up to 2.2 PB.
Storage protocols	• NAS (File access): NFS and CIFS/SMB. • SAN (Block access): iSCSI and FC.
Host connectivity	Base ports (per controller enclosure): • 8x 1 GbE (RJ-45 UTP)/10 GbE (DAC cable or SW fiber optic cable, LC) or 4/8/16 Gb FC (SW fiber optic cable, LC) SFP+ host ports (4 ports per controller); or • 8x 1/10 GbE RJ-45 UTP host ports (4 ports per controller).
Host operating systems	Microsoft Windows Server 2012 R2, 2016, and 2019; Red Hat Enterprise Linux (RHEL) 6 and 7; SUSE Linux Enterprise Server (SLES) 11, 12, and 15; VMware vSphere 6.0, 6.5, and 6.7.
Standard software features	RAID data protection, snapshots, volume copy (FlexClone), storage quality of service (QoS), thin provisioning, compression, deduplication, encryption, disk-based backup (SnapVault), application-aware backup (SnapCenter), quick data recovery (SnapRestore), clustering, clustering with data mirroring (MetroCluster IP), and synchronous and asynchronous replication (SnapMirror).
Optional software features	WORM data protection (SnapLock) and object storage tiering (FabricPool).
Performance*	Up to 148 000 random read IOPS (8 KB blocks).

Configuration maximums**	• Maximum raw storage capacity: 2.2 PB
	• Maximum aggregate size: 400 TB
	• Maximum number of FlexVol volumes per controller: 1000
	• Maximum FlexVol volume size: 100 TB
	• Maximum number of LUNs per controller: 8192
	• Maximum number of LUNs per FlexVol volume: 512
	• Maximum LUN size: 16 TB
	• Maximum number of drives in a RAID group (data + parity drives):
	  ◦ RAID 4: 14 (13 + 1 SAS SSDs) or 7 (6 + 1 NL SAS HDDs)
	  ◦ RAID-DP: 28 (26 + 2 SAS SSDs) or 20 (18 + 2 NL SAS HDDs)
	  ◦ RAID-TEC: 29 (26 + 3 SAS SSDs or NL SAS HDDs)
	• Maximum number of initiators per controller: 2048
	• Maximum number of snapshots per FlexVol volume: 1023

Cooling	Redundant cooling with the fans that are built into power supplies (DM5000F and DM240S 2U24 SFF enclosures).
Power supply	Two redundant hot-swap 913 W (100 - 240 V) (DM5000F and DM240S 2U24 enclosures) Platinum AC power supplies.
Hot-swap parts	Controllers, I/O modules, drives, power supplies, and SFP+ transceivers and DAC cables.
Management ports	• 1x 1 GbE port (UTP, RJ-45) per controller for out-of-band management. • 2x Serial console ports (RJ-45 and Micro-USB) for system configuration.
Management interfaces	ThinkSystem Storage Manager web-based GUI; SSH CLI; Serial console CLI; SNMP, email, and syslog alerts; optional Lenovo XClarity.
Security features	Secure Socket Layer (SSL), Secure Shell (SSH), user level security, role-based access control (RBAC), LDAP authentication.

Attribute	Specification
Warranty and support	Three-, four-, or five-year customer-replaceable unit and onsite limited warranty with selectable service levels: 9x5 service coverage next business day (NBD) onsite response (Foundation) or 24x7 service coverage with 4-hour onsite response (Essential). Premier Support is also available.
Software maintenance	Included in the warranty and support.
Dimensions	Controller enclosure: • Height: 85 mm (3.4 in.) • Width: 447 mm (17.6 in.) • Depth: 483 mm (19.0 in.) 2U24 SFF expansion enclosure: • Height: 85 mm (3.4 in.) • Width: 449 mm (17.7 in.) • Depth: 484 mm (19.1 in.)
Weight	• Controller enclosure (fully configured): 27.6 kg (60.8 lb) • 2U24 SFF expansion enclosure (fully configured): 24.4 kg (53.8 lb)

* Estimated performance based on internal measurements.
** For a detailed list of configuration limits and restrictions for a specific version of the software, refer to the Lenovo Data Center Support website:
http://datacentersupport.lenovo.com

Controller enclosures

Preconfigured and factory-integrated models of the ThinkSystem DM5000F Unified Flash Storage Array are configured by using the Lenovo Data Center Solution Configurator (DCSC):
http://dcsc.lenovo.com

The following table lists the preconfigured models of the ThinkSystem DM5000F.

Table 2. ThinkSystem DM5000F preconfigured models

Description	Part number
Relationship models - Europe, Middle East, and Africa (EMEA)	
ThinkSystem DM5000F, 11.5TB (12x 960GB SSDs), 10GBASE-T, 2x 0.5m Passive DAC SFP+ cables, ONTAP 9.5 SW, Encryption (No support included*)	7Y411002EA
ThinkSystem DM5000F, 11.5TB (12x 960GB SSDs), 16Gb FC / 10GbE SFP+, 2x 0.5m Passive DAC SFP+ cables, ONTAP 9.5 SW, Encryption (No support included*)	7Y411001EA
ThinkSystem DM5000F, 23TB (24x 960GB SSDs), 10GBASE-T, 2x 0.5m Passive DAC SFP+ cables, ONTAP 9.5 SW, Encryption (No support included*)	7Y411004EA
ThinkSystem DM5000F, 23TB (24x 960GB SSDs), 16Gb FC / 10GbE SFP+, 2x 0.5m Passive DAC SFP+ cables, ONTAP 9.5 SW, Encryption (No support included*)	7Y411003EA
ThinkSystem DM5000F, 46TB (12x 3.84TB SSDs), 10GBASE-T, 2x 0.5m Passive DAC SFP+ cables, ONTAP 9.5 SW, Encryption (No support included*)	7Y411006EA
ThinkSystem DM5000F, 46TB (12x 3.84TB SSDs), 16Gb FC / 10GbE SFP+, 2x 0.5m Passive DAC SFP+ cables, ONTAP 9.5 SW, Encryption (No support included*)	7Y411005EA
ThinkSystem DM5000F, 92TB (24x 3.84TB SSDs), 10GBASE-T, 2x 0.5m Passive DAC SFP+ cables, ONTAP 9.5 SW, Encryption (No support included*)	7Y411007EA
ThinkSystem DM5000F, 92TB (24x 3.84TB SSDs), 16Gb FC / 10GbE SFP+, 2x 0.5m Passive DAC SFP+ cables, ONTAP 9.5 SW, Encryption (No support included*)	7Y411000EA

* Support must be purchased with the storage system (See Warranty and support for details).

The following table lists the CTO base models for the ThinkSystem DM5000F.

Table 3. ThinkSystem DM5000F CTO base models

Description	Machine Type/Model	Feature code
Lenovo ThinkSystem Storage 2U24 Chassis (2x PSUs, No controller modules)	7Y41CTO1WW	B38L

Configuration note: Two DM3000/DM5000 SFP+ controllers (feature code B39F) must be selected during the configuration process.

The models of the ThinkSystem DM5000F ship with the following items:

- One chassis with the following components:
  - Two controllers
  - Two power supplies
- Rack Mount Kit
- 2 m USB Cable (USB Type A to Micro-USB)
- *Electronic Publications Flyer*
- Two customer-configured power cables

Controllers

The ThinkSystem DM5000F controller enclosures ship with two DM3000/DM5000 10GBASE-T or SFP+ controllers. A *controller* provides interfaces for host connectivity, management, and internal drives, and it runs ONTAP storage management software. Each DM5000F controller enclosure provides 64 GB RAM and 8 GB battery-backed NVRAM (32 GB RAM and 4 GB NVRAM per controller).

The ThinkSystem DM5000F controller enclosures ship with four interconnect 10 GbE SFP+ ports (two ports per controller) to cable a directly-connected dual-controller HA pair or for switched cluster interconnect with multiple dual-controller HA pairs. Up to six HA pairs can be combined into a single SAN cluster or up to 12 HA pairs can be combined into a single NAS cluster.

The ThinkSystem DM5000H controller enclosures ship with one of the following interface types:

- 8x Universal SFP+ ports (four ports per controller) for 1/10 GbE NAS / iSCSI or 4/8/16 Gb FC host connectivity.
- 8x 1/10 GbE RJ-45 ports (four ports per controller) for 1/10 GbE NAS / iSCSI host connectivity.

Each DM5000F controller enclosure also provides four integrated 12 Gb SAS x4 expansion ports (Mini-SAS HD SFF-8644 connectors) (two ports per controller) for the attachment of the ThinkSystem DM Series expansion enclosures.

Configuration notes:

- A pair of the universal SFP+ base ports (e0c/0c and e0d/0d or e0e/0e and e0f/0f) in the system must have the same connectivity type (either Ethernet or Fibre Channel, but not both types) and the same type of physical connections; different pairs might have different types of connectivity.
- Two controllers are required for selection. Both controllers must be of the same type (either 16 Gb FC / 10 GbE or 10GBASE-T, but not both types), and they must have matching configurations of the base ports (type and physical connections).

The following table lists the controller for the DM5000F Storage Array and supported connectivity options.

Table 4. DM5000F controllers and connectivity options

Description	Part number	Feature code	Maximum quantity per controller enclosure
Controllers			
Lenovo ThinkSystem DM3000/DM5000 Controller, 10GBASE-T	None*	B39G	2
Lenovo ThinkSystem DM3000/DM5000 Controller, 16Gb FC / 10GbE	None*	B39F	2
SFP+ options for base ports			
1Gb RJ-45 iSCSI SFP+ Module 1 pack	4XF7A14917	B4K7	8
8Gb Fibre Channel SFP+ Module 1 pack	4XF7A14918	B4K8	8
16Gb Fibre Channel SFP+ Module 1 pack	4XF7A14920	B4KA	8
SFP+ options for base ports and interconnect ports			
10Gb SW Optical iSCSI SFP+ Module 1 pack	4XF7A14919	B4K9	12
OM4 cable options for 8 Gb FC, 16 Gb FC, and 10 GbE SW SFP+ optical transceivers			
Lenovo 0.5m LC-LC OM4 MMF Cable	4Z57A10845	B2P9	12
Lenovo 1m LC-LC OM4 MMF Cable	4Z57A10846	B2PA	12
Lenovo 3m LC-LC OM4 MMF Cable	4Z57A10847	B2PB	12
Lenovo 5m LC-LC OM4 MMF Cable	4Z57A10848	B2PC	12
Lenovo 10m LC-LC OM4 MMF Cable	4Z57A10849	B2PD	12
Lenovo 15m LC-LC OM4 MMF Cable	4Z57A10850	B2PE	12
Lenovo 25m LC-LC OM4 MMF Cable	4Z57A10851	B2PF	12
Lenovo 30m LC-LC OM4 MMF Cable	4Z57A10852	B2PG	12
OM3 cable options for 8 Gb FC, 16 Gb FC, and 10 GbE SW SFP+ optical transceivers			
Lenovo 0.5m LC-LC OM3 MMF Cable	00MN499	ASR5	12
Lenovo 1m LC-LC OM3 MMF Cable	00MN502	ASR6	12
Lenovo 3m LC-LC OM3 MMF Cable	00MN505	ASR7	12
Lenovo 5m LC-LC OM3 MMF Cable	00MN508	ASR8	12
Lenovo 10m LC-LC OM3 MMF Cable	00MN511	ASR9	12
Lenovo 15m LC-LC OM3 MMF Cable	00MN514	ASRA	12
Lenovo 25m LC-LC OM3 MMF Cable	00MN517	ASRB	12
Lenovo 30m LC-LC OM3 MMF Cable	00MN520	ASRC	12
DAC cable options for 10 GbE SFP+ connectivity (SFP+ base ports and interconnect ports)			
0.5m Passive DAC SFP+ Cable	00D6288	A3RG	12
1m Passive DAC SFP+ Cable	90Y9427	A1PH	12
1.5m Passive DAC SFP+ Cable	00AY764	A51N	12
2m Passive DAC SFP+ Cable	00AY765	A51P	12
3m Passive DAC SFP+ Cable	90Y9430	A1PJ	12
5m Passive DAC SFP+ Cable	90Y9433	A1PK	12
7m Passive DAC SFP+ Cable	00D6151	A3RH	12
UTP Category 6 cables options for 1/10 GbE RJ-45 host connectivity and 1 GbE RJ-45 management ports			
0.75m Green Cat6 Cable	00WE123	AVFW	10

Description	Part number	Feature code	Maximum quantity per controller enclosure
1.0m Green Cat6 Cable	00WE127	AVFX	10
1.25m Green Cat6 Cable	00WE131	AVFY	10
1.5m Green Cat6 Cable	00WE135	AVFZ	10
3m Green Cat6 Cable	00WE139	AVG0	10
10m Green Cat6 Cable	90Y3718	A1MT	10
25m Green Cat6 Cable	90Y3727	A1MW	10

* Factory-installed only.

Expansion enclosures

The ThinkSystem DM5000F supports attachment of up to five ThinkSystem DM240S 2U24 SFF enclosures. The expansion enclosures can be added to the system non-disruptively.

The following table lists the CTO base models for the ThinkSystem DM Series expansion enclosures.

Table 5. CTO base models for the ThinkSystem DM Series expansion enclosures

Description	Machine Type/Model	Feature code
Lenovo ThinkSystem Storage 2U24 Chassis (with 2x PSUs)	7Y58CTO1WW	B38L

Configuration note: Two I/O expansion modules (feature code B39J) are pre-selected by the configurator.

The models of the ThinkSystem DM240S ship with the following items:

- One chassis with the following components:
  - Two I/O modules
  - Two power supplies
- Rack Mount Kit
- *Electronic Publications Flyer*
- Two customer-configured power cables

Each ThinkSystem DM Series expansion enclosure ships with two SAS I/O expansion modules. Each *I/O expansion module* provides two external 12 Gb SAS x4 ports (Mini-SAS HD SFF-8644 connectors labelled Port 1-4) that are used for connections to the ThinkSystem DM5000F and for daisy chaining the expansion enclosures between each other.

The dual-path HA (high availability) connectivity topology for the enclosures is shown in the following figure.

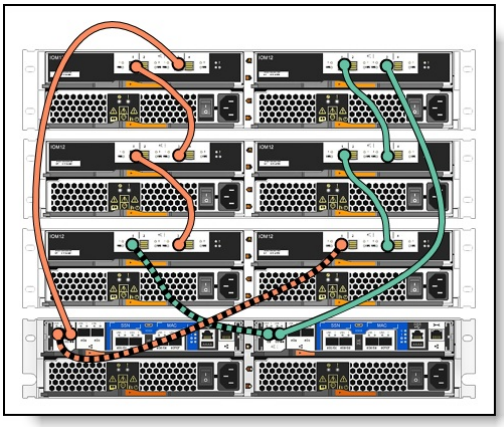


Figure 6. DM5000F expansion enclosure connectivity topology

Expansion cabling rules:

- Port 0b on the Controller 1 is the primary path that is connected to the Port 3 on the I/O Module A in the last expansion enclosure in a stack.
- Port 1 on the I/O Module A in the last expansion enclosure is connected to Port 3 on the I/O Module A in the adjacent expansion enclosure, and so on (until the first expansion enclosure in a stack is cabled).
- Port 0a on the Controller 1 is the secondary path that is connected to the Port 1 on the I/O Module B in the first expansion enclosure in a stack.
- Port 0b on the Controller 2 is the primary path that is connected to the Port 3 on the I/O Module B in the last expansion enclosure in a stack.
- Port 1 on the I/O Module B in the last expansion enclosure is connected to Port 3 on the I/O Module B in the adjacent expansion enclosure, and so on (until the first expansion enclosure in a stack is cabled).
- Port 0a on the Controller 2 is the secondary path that is connected to the Port 1 on the I/O Module A in the first expansion enclosure in a stack.

The following table lists ordering information for the supported expansion enclosure connectivity options.

Table 6. Expansion enclosure connectivity options

Description	Part number	Feature code	Maximum quantity per one expansion enclosure
External MiniSAS HD 8644/MiniSAS HD 8644 0.5M Cable	00YL847	AU16	4
External MiniSAS HD 8644/MiniSAS HD 8644 1M Cable	00YL848	AU17	4
External MiniSAS HD 8644/MiniSAS HD 8644 2M Cable	00YL849	AU18	4
External MiniSAS HD 8644/MiniSAS HD 8644 3M Cable	00YL850	AU19	4

Configuration note: The following quantities of SAS cables are needed for the stack of the expansion enclosures:

- Two SAS cables per expansion enclosure in the stack for connecting the first expansion enclosure in the stack to the controller enclosure and for connections to the adjacent expansion enclosures.
- Two additional SAS cables for connecting the last expansion enclosure in the stack to the controller enclosure.

Drives

The ThinkSystem DM5000F and DM240S 2U24 SFF enclosures support up to 24 SFF hot-swap drives. The following table lists supported drive options for the DM5000F and DM240S 2U24 SFF enclosures.

Table 7. DM5000F and DM240S 2U24 SFF drive options

Description	Part number	Feature code	Maximum quantity per 2U24 enclosure
2.5-inch 12 Gbps SAS hot-swap SSDs (1 Drive Write per Day)			
ThinkSystem 5.76TB (6x 960GB SAS SSDs) 2U24 Drive Pack for DM5000F	4XB7A16938	B65P	4
ThinkSystem 23.04TB (6x 3.84TB SAS SSDs) 2U24 Drive Pack for DM5000F	4XB7A16940	B65R	4
ThinkSystem 46.08TB (6x 7.68TB SAS SSDs) 2U24 Drive Pack for DM5000F	4XB7A16942	B65T	4
ThinkSystem 92.16TB (6x 15.36TB SAS SSDs) 2U24 Drive Pack for DM5000F	4XB7A16944	B65V	4

Configuration notes:

- The DM5000F 2U24 SFF controller enclosures support from 12 to 24 drives in increments of 6 drives, and all drives in the enclosure must be of the same type and capacity.
- The DM240S 2U24 SFF expansion enclosures support from 6 to 24 drives in increments of 6 drives, and all drives in the enclosure must be of the same type and capacity.

Software

The following functions are included with the ThinkSystem DM5000F software:

- **RAID-4, RAID-DP, and RAID-TEC data protection**: Provides the flexibility to choose the level of data protection required and helps improve performance and availability with built-in spare capacity and by distributing data across all physical drives in the aggregate, sustaining to up to one (RAID-4), two (RAID-DP), or three (RAID-TEC) concurrent drive failures.
- **SyncMirror data protection:** Adds extra level of data protection and availability by mirroring a pair of RAID aggregates.
- **All Flash Array (AFA) capability**: Meets the demand for higher speed, lower latency storage and provides higher IOPS and bandwidth with lower power usage and total cost of ownership than hybrid or HDD-based solutions.
- **FlexVol:** Provides abstraction layer between the logical volume and its physical location in the storage array.
- **FlexGroup:** Enables a single volume to span across multiple clustered storage arrays to maximize storage capacity and automate load distribution.
- **FlexCache:** Speeds up access to data and offloads traffic from heavily accessed volumes for read-intensive workloads by placing frequently used data in cache locally or remotely (closer to the point of client access) and serving the data to the clients directly from cache without accessing the data source.
- **Thin provisioning**: Optimizes efficiency by allocating storage space based on the minimum space required by each application at any given time, so that applications consume only the space they are actually using, not the total space that has been allocated to them, which allows customers to purchase storage they need today and add more as application requirements grow.
- **Compression:** Provides transparent inline and post-process data compression to reduce the amount of storage that customers need to purchase and manage.

- **Compaction:** Works with compression to pack more data into each storage block to further reduce the amount of storage that customers need to purchase and manage.
- **Deduplication:** Performs general-purpose deduplication for removal of redundant data to reduce the amount of storage that customers need to purchase and manage.
- **Snapshots**: Enables creation of read-only copies of data for backup, parallel processing, testing, and development, and have the copies available almost immediately.
- **FlexClone:** References snapshot metadata to create writable point-in-time copies of a volume.
- **Encryption:** Provides software-based encryption for data at rest for enhanced data security with the traditional drives and embedded key management (requires the encryption-capable version of the ONTAP software [feature code B4D0]).
- **Balanced placement:** Provides automated workload distribution across the cluster to help increase utilization and performance.
- **Dynamic capacity expansion:** Allows the capacity of a volume or aggregate to be expanded by adding new physical drives.
- **Adaptive Quality of Service:** Simplifies operations and maintains consistent workload performance by defining QoS policies and automatically adjusting storage resources to respond to workload changes.
- **SnapVault disk-based storage backup:** Enables data stored on multiple systems to be backed up to a central, secondary system quickly and efficiently as read-only snapshot copies.
- **SnapRestore:** Enables quick recovery of data by reverting a local volume or file to its previous state from a particular snapshot copy stored on the file system.
- **SnapCenter:** Provides application- and virtual machine-aware backup and restoration of data by using the Snapshots technology and leverages the SnapMirror capabilities of storage systems to provide onsite or offsite backup set mirroring for disaster recovery.
- **MetroCluster IP:** Provides storage system-based clustering with online, real-time data mirroring between the local and remote sites by using synchronous data transfers over iSCSI communication links to deliver continuous availability with zero RPO and near-zero RTO.
  Note: All storage systems in a MetroCluster IP configuration must be of the same model.
- **SnapMirror synchronous and asynchronous replication:** Provides storage system-based data replication between the storage systems containing source (local) and destination (remote) volumes by using synchronous (as soon as the data is written to the source volume) or asynchronous (at specified regular intervals) data transfers over iSCSI or Fibre Channel communication links.
  Note: The SnapMirror feature of the ThinkSystem DM5000F interoperate with other ThinkSystem DM Series storage arrays.

The following table lists the software selection options for the ThinkSystem DM5000F.

Table 8. Software selection

Description	Feature code
Lenovo ThinkSystem DM Series ONTAP 9.5 SW, Encryption	B6KC
Lenovo ThinkSystem DM Series ONTAP 9.5 SW, Non-Encryption	B6KD
Lenovo ThinkSystem DM Series ONTAP 9.6 SW, Encryption	B79W
Lenovo ThinkSystem DM Series ONTAP 9.6 SW, No Encryption	B79X

Configuration note: The encryption-capable version of the ONTAP Software is not available in the following countries:

- Belarus
- Kazakhstan
- People's Republic of China
- Russia

Software maintenance is included in the ThinkSystem DM5000F warranty and support (see Warranty and support for details).

The ThinkSystem DM5000F capabilities can be expanded with the following optional licensed functions:

- **SnapLock WORM data protection:** Creates non-rewritable, non-erasable data on hard disk drives to prevent files from being altered or deleted until a predetermined or default retention date.
- **FabricPool object storage tiering:** Enables automated tiering of data from high-performance SSDs (active data) to lower-cost object storage in public or private clouds (inactive data).

The following table lists the Feature on Demand (FoD) upgrades for the ThinkSystem DM5000F to enable optional software features.

Table 9. Optional software features

Description	Part number	Feature code	Quantity
DM Series SnapLock License	4P47A16547	None*	1**
DM Series FabricPool – 1TB Increment – 3 years	4P47A37057	None*	1^
DM Series FabricPool – 1TB Increment – 5 years	4P47A37288	None*	1^

* Field upgrade only; no factory installation.
** Quantity per system; contains two licenses.
^ Quantity per TB of storage capacity.

Configuration notes:

- The SnapLock feature is licensed on a per-controller basis; that is, two licenses are needed per system, and these two licenses are contained in a single orderable part number. These licenses also include 5-year software support entitlement.
- The FabricPool feature is a cluster-wide, capacity-based license that is available for 3- or 5-year subscription terms.

Management

The ThinkSystem DM5000F supports the following management interfaces:

- Lenovo ThinkSystem Storage Manager, a web-based interface via HTTPS for single-system management or centralized management of the cluster of systems, that runs on the storage system itself and requires only a supported browser (Microsoft Internet Explorer, Google Chrome, or Mozilla Firefox), so there is no need for a separate console or plug-in.
- Command line interface (CLI) via SSH or through serial console.
- Syslog, SNMP, and e-mail notifications.
- Optional Lenovo XClarity for discovery, inventory, monitoring, and alerts.

Power supplies and cables

The ThinkSystem DM5000F and DM240S 2U24 SFF enclosures ship with two redundant hot-swap 913 W (100 - 240 V) Platinum AC power supplies, each with an IEC 320-C14 connector.

Each ThinkSystem DM Series enclosure requires the selection of two power cables. The following table lists the rack power cable and line cord options that can be ordered for the DM5000F and DM240S 2U24 SFF enclosures (two power cords per enclosure).

Table 10. Power cables for DM5000F and DM240S 2U24 SFF enclosures

Description	Part number	Feature code
Rack power cables		
1.0m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	00Y3043	A4VP
1.0m, 13A/100-250V, C13 to IEC 320-C14 Rack Power Cable	4L67A08367	B0N5
1.2m, 16A/100-250V, 2 Short C13s to Short C20 Rack Power Cable	47C2491	A3SW
1.5m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	39Y7937	6201
1.5m, 13A/100-250V, C13 to IEC 320-C14 Rack Power Cable	4L67A08368	B0N6
2.0m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	4L67A08365	B0N4
2.0m, 13A/125V-10A/250V, C13 to IEC 320-C14 Rack Power Cable	4L67A08369	6570
2.5m, 16A/100-250V, 2 Long C13s to Short C20 Rack Power Cable	47C2492	A3SX
2.8m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	4L67A08366	6311
2.8m, 13A/125V-10A/250V, C13 to IEC 320-C14 Rack Power Cable	4L67A08370	6400
2.8m, 10A/100-250V, C13 to IEC 320-C20 Rack Power Cable	39Y7938	6204
2.8m, 16A/100-250V, 2 Short C13s to Long C20 Rack Power Cable	47C2493	A3SY
4.1m, 16A/100-250V, 2 Long C13s to Long C20 Rack Power Cable	47C2494	A3SZ
4.3m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	39Y7932	6263
4.3m, 13A/125V-10A/250V, C13 to IEC 320-C14 Rack Power Cable	4L67A08371	6583
Line cords		
Argentina 2.8m, 10A/250V, C13 to IRAM 2073 Line Cord	39Y7930	6222
Argentina 4.3m, 10A/250V, C13 to IRAM 2073 Line Cord	81Y2384	6492
Australia/New Zealand 2.8m, 10A/250V, C13 to AS/NZS 3112 Line Cord	39Y7924	6211
Australia/New Zealand 4.3m, 10A/250V, C13 to AS/NZS 3112 Line Cord	81Y2383	6574
Brazil 2.8m, 10A/250V, C13 to NBR 14136 Line Cord	69Y1988	6532
Brazil 4.3m, 10A/250V, C13 to NBR14136 Line Cord	81Y2387	6404
China 2.8m, 10A/250V, C13 to GB 2099.1 Line Cord	39Y7928	6210
China 4.3m, 10A/250V, C13 to GB 2099.1 Line Cord	81Y2378	6580
Denmark 2.8m, 10A/250V, C13 to DK2-5a Line Cord	39Y7918	6213
Denmark 4.3m, 10A/250V, C13 to DK2-5a Line Cord	81Y2382	6575
Europe 2.8m, 10A/250V, C13 to CEE7-VII Line Cord	39Y7917	6212
Europe 4.3m, 10A/250V, C13 to CEE7-VII Line Cord	81Y2376	6572
India 2.8m, 10A/250V, C13 to IS 6538 Line Cord	39Y7927	6269
India 4.3m, 10A/250V, C13 to IS 6538 Line Cord	81Y2386	6567
Israel 2.8m, 10A/250V, C13 to SI 32 Line Cord	39Y7920	6218
Israel 4.3m, 10A/250V, C13 to SI 32 Line Cord	81Y2381	6579
Italy 2.8m, 10A/250V, C13 to CEI 23-16 Line Cord	39Y7921	6217

Description	Part number	Feature code
Italy 4.3m, 10A/250V, C13 to CEI 23-16 Line Cord	81Y2380	6493
Japan 2.8m, 12A/125V, C13 to JIS C-8303 Line cord	46M2593	A1RE
Japan 2.8m, 12A/250V, C13 to JIS C-8303 Line Cord	4L67A08357	6533
Japan 4.3m, 12A/125V, C13 to JIS C-8303 Line Cord	39Y7926	6335
Japan 4.3m, 12A/250V, C13 to JIS C-8303 Line Cord	4L67A08362	6495
Korea 2.8m, 12A/250V, C13 to KS C8305 Line Cord	39Y7925	6219
Korea 4.3m, 12A/250V, C13 to KS C8305 Line Cord	81Y2385	6494
South Africa 2.8m, 10A/250V, C13 to SABS 164 Line Cord	39Y7922	6214
South Africa 4.3m, 10A/250V, C13 to SABS 164 Line Cord	81Y2379	6576
Switzerland 2.8m, 10A/250V, C13 to SEV 1011-S24507 Line Cord	39Y7919	6216
Switzerland 4.3m, 10A/250V, C13 to SEV 1011-S24507 Line Cord	81Y2390	6578
Taiwan 2.8m, 10A/125V, C13 to CNS 10917-3 Line Cord	23R7158	6386
Taiwan 2.8m, 10A/250V, C13 to CNS 10917-3 Line Cord	81Y2375	6317
Taiwan 2.8m, 15A/125V, C13 to CNS 10917-3 Line Cord	81Y2374	6402
Taiwan 4.3m, 10A/125V, C13 to CNS 10917-3 Line Cord	4L67A08363	AX8B
Taiwan 4.3m, 10A/250V, C13 to CNS 10917-3 Line Cord	81Y2389	6531
Taiwan 4.3m, 15A/125V, C13 to CNS 10917-3 Line Cord	81Y2388	6530
United Kingdom 2.8m, 10A/250V, C13 to BS 1363/A Line Cord	39Y7923	6215
United Kingdom 4.3m, 10A/250V, C13 to BS 1363/A Line Cord	81Y2377	6577
United States 2.8m, 10A/125V, C13 to NEMA 5-15P Line Cord	90Y3016	6313
United States 2.8m, 10A/250V, C13 to NEMA 6-15P Line Cord	46M2592	A1RF
United States 2.8m, 13A/125V, C13 to NEMA 5-15P Line Cord	00WH545	6401
United States 4.3m, 10A/125V, C13 to NEMA 5-15P Line Cord	4L67A08359	6370
United States 4.3m, 10A/250V, C13 to NEMA 6-15P Line Cord	4L67A08361	6373
United States 4.3m, 13A/125V, C13 to NEMA 5-15P Line Cord	4L67A08360	AX8A

Rack installation

The individually shipped ThinkSystem DM5000F and DM240S enclosures come with the ThinkSystem Storage Rack Mount Kit 2U24/4U60 listed in the following table.

Table 11. 4-post rack mount kit

Description	Feature code	Quantity
Lenovo ThinkSystem Storage Rack Mount Kit 2U24/4U60	B38Y	1

When the ThinkSystem DM Series enclosures are factory-integrated and shipped installed in a rack cabinet, the rack mount kits that support Ship-in-Rack (SIR) capabilities are derived by the configurator. The SIR-capable rack mount kits are listed in the following table.

Table 12. 4-post SIR rack mount kits

Description	Feature code	Quantity
Lenovo ThinkSystem Storage SIR Rack Mount Kit (for 2U24 enclosures)	B6TH	1

The following table summarizes the rack mount kit features and specifications.

Table 13. Rack mount kit features and specifications summary

	Screw-in fixed rail with adjustable depth	
Attribute	**2U24/4U60**	**2U24 SIR**
Feature code	B38Y	B6TH
Enclosure support	DM5000F, DM240S	DM5000F, DM240S
Rail type	Fixed (static) with adjustable depth	Fixed (static) with adjustable depth
Tool-less installation	No	No
In-rack maintenance	Yes*	Yes*
Ship-in-rack (SIR) support	No	Yes
1U PDU support	Yes	Yes
0U PDU support	Limited**	Limited**
Rack type	IBM or Lenovo 4-post, IEC standard-compliant	IBM or Lenovo 4-post, IEC standard-compliant
Mounting holes	Square or round	Square or round
Mounting flange thickness	2 mm (0.08 in.) – 3.3 mm (0.13 in.)	2 mm (0.08 in.) – 3.3 mm (0.13 in.)
Distance between front and rear mounting flanges^	605 mm (23.8 in.) – 812.8 mm (32 in.)	605 mm (23.8 in.) – 812.8 mm (32 in.)

* The majority of the enclosure components can be serviced from the front or rear of the enclosure, which does not require the removal of the enclosure from the rack cabinet.
** If a 0U PDU is used, the rack cabinet must be at least 1000 mm (39.37 in.) deep for 2U24 enclosures.
^ Measured when mounted on the rack, from the front surface of the front mounting flange to the rear most point of the rail.

Physical specifications

The ThinkSystem DM5000F controller enclosure has the following dimensions and weight (approximate):

- Height: 85 mm (3.4 in.)
- Width: 447 mm (17.6 in.)
- Depth: 483 mm (19.0 in.)
- Weight (fully configured): 27.6 kg (60.8 lb)

The ThinkSystem DM240S 2U24 SFF enclosures have the following dimensions and weight (approximate):

- Height: 85 mm (3.4 in.)
- Width: 449 mm (17.7 in.)
- Depth: 484 mm (19.1 in.)
- Weight (fully configured): 24.4 kg (53.8 lb)

Operating environment

The ThinkSystem DM5000F and DM240S 2U24 SFF enclosures are supported in the following environment:

- Air temperature:
  - Operating: 5 °C - 45 °C (41 °F - 113 °F)
  - Non-operating: -40 °C - +70 °C (-40 °F - 158 °F)
  - Maximum altitude: 3050 m (10,000 ft)
- Relative humidity:
  - Operating: 8% - 90% (non-condensing)
  - Non-operating: 10% - 95% (non-condensing)
- Electrical power:
  - DM5000F
    - 100 to 127 (nominal) V AC; 50 Hz or 60 Hz; 5.52 A
    - 200 to 240 (nominal) V AC; 50 Hz or 60 Hz; 2.76 A
    - Maximum system power load: 524 W
  - DM240S 2U24 SFF
    - 100 to 127 (nominal) V AC; 50 Hz or 60 Hz; 4.11 A
    - 200 to 240 (nominal) V AC; 50 Hz or 60 Hz; 2.05 A
    - Maximum system power load: 390 W
- Heat dissipation:
  - DM5000F: 1788 BTU/hour
  - DM240S 2U24 SFF: 1331 BTU/hour
- Acoustical noise emission:
  - DM5000F: 6.9 bels
  - DM240S 2U24 SFF: 6.9 bels

Warranty and support

The ThinkSystem DM Series enclosures can be configured with a three-, four, or five-year Customer Replaceable Unit (CRU) and onsite limited warranty with various levels of coverage with a well-defined scope of services, including service hours, response time, term of service, and service agreement terms and conditions.

Lenovo's support services provide a sophisticated, unified support structure for a customer's data center, with an experience consistently ranked number one in customer satisfaction worldwide.

The following Lenovo support services are available:

- **Premier Support** provides a Lenovo-owned customer experience and delivers direct access to technicians skilled in hardware, software, and advanced troubleshooting, in addition to the following capabilities:
  - Direct technician-to-technician access through a dedicated phone line.
  - 24x7x365 remote support.
  - Single point of contact service.
  - End to end case management.
  - 3rd Party collaborative software support.
  - Online case tools and live chat support.
  - On-demand remote system analysis.
- **Warranty Service Levels (Preconfigured Support)** are available to meet the on-site response time targets that match the criticality of customer's systems:
  - 3, 4, or 5 years of service coverage.
  - **Foundation Service:** 9x5 service coverage with next business day onsite response.
  - **Essential Service:** 24x7 service coverage with 4-hour onsite response.

  Note: Either Foundation or Essential Service *must* be purchased with the storage system (for controller enclosures, expansion enclosures, and drive packs).
- **Managed Services**
  Lenovo Managed Services provide continuous 24x7 remote monitoring (plus 24x7 call center availability) and proactive management of a customer's data center using state of the art tools, systems, and practices by a team of highly skilled and experienced Lenovo services professionals. Quarterly reviews check error logs, verify firmware and operating system device driver levels, and software as needed. Lenovo will also maintain records of latest patches, critical updates, and firmware levels, to ensure customer's systems are providing business value through optimized performance.
- **Technical Account Management (TAM)**
  A Lenovo Technical Account Manager helps customers optimize operations of their data centers based on a deep understanding of customer's business. Customers gain direct access to a Lenovo TAM, who serves as their single point of contact to expedite service requests, provide status updates, and furnish reports to track incidents over time. Also, a TAM helps proactively make service recommendations and manage service relationship with Lenovo to make certain that customer's needs are met.
- **Health Check**
  Having a trusted partner who can perform regular and detailed health checks is central to maintaining efficiency and ensuring that customer systems and business are always running at their best. Health Check supports Lenovo-branded server, storage, and networking devices, as well as select Lenovo-supported products from other vendors that are sold by Lenovo or a Lenovo-Authorized Reseller.

Some regions might have different warranty terms and conditions than the standard warranty. This is due to local business practices or laws in the specific region. Local service teams can assist in explaining region-specific terms when needed. Examples of region-specific warranty terms are second or longer business day parts delivery or parts-only base warranty.

If warranty terms and conditions include onsite labor for repair or replacement of parts, Lenovo will dispatch a service technician to the customer site to perform the replacement. Onsite labor under base warranty is limited to labor for replacement of parts that have been determined to be field-replaceable units (FRUs). Parts that are determined to be customer-replaceable units (CRUs) do not include onsite labor under base warranty.

If warranty terms include parts-only base warranty, Lenovo is responsible for delivering only replacement parts that are under base warranty (including FRUs) that will be sent to a requested location for self-service. Parts-only service does not include a service technician being dispatched onsite. Parts must be changed at customer's own cost and labor and defective parts must be returned following the instructions supplied with the spare parts.

Lenovo support services are region-specific. Not all support services are available in every region. For information about Lenovo support services that are available in a specific region, refer to the following resources:

- Service part numbers in Data Center Solution Configurator (DCSC):
  http://dcsc.lenovo.com/#/services
- Lenovo Services Availability Locator
  https://lenovolocator.com/

For service definitions, region-specific details, and service limitations, refer to the following documents:

- Lenovo Statement of Limited Warranty for Data Center Group (DCG) Servers and System Storage
  http://pcsupport.lenovo.com/us/en/solutions/ht503310
- Lenovo Data Center Services Agreement
  http://support.lenovo.com/us/en/solutions/ht116628

Services

Lenovo Services is a dedicated partner to customer success. Lenovo's goal for customers is to reduce capital outlays, mitigate IT risks, and accelerate time to productivity.

Here is a more in-depth look at what Lenovo can do for their customers:

- **Asset Recovery Services**
  Asset Recovery Services (ARS) helps customers recover the maximum value from their end-of-life equipment in a cost-effective and secure way. On top of simplifying the transition from old to new equipment, ARS mitigates environmental and data security risks associated with data center equipment disposal. Lenovo ARS is a cash-back solution for equipment based on its remaining market value, yielding maximum value from aging assets and lowering total cost of ownership for customers.
- **Assessment Services**
  An assessment helps solve customer IT challenges through an onsite, multi-day session with a Lenovo technology expert. Lenovo performs a tools-based assessment which provides a comprehensive and thorough review of a company's environment and technology systems. In addition to the technology-based functional requirements, the consultant also discusses and records the non-functional business requirements, challenges, and constraints. Assessments help organizations, no matter how large or small, get a better return on their IT investment and overcome challenges in the ever-changing technology landscape.
- **Design Services**
  Professional Services consultants perform infrastructure design and implementation planning to support customer's strategy. The high-level architectures provided by the assessment service are turned into low level designs and wiring diagrams, which are reviewed and approved prior to implementation. The implementation plan will demonstrate an outcome-based proposal to provide business capabilities through infrastructure with a risk-mitigated project plan.

- **Basic Hardware Installation**
  Lenovo experts can seamlessly manage the physical installation of customer's server, storage, or networking hardware. Working at a time convenient for the customer (business hours or off shift), the technician will unpack and inspect the systems on customer site, install options, mount in a rack cabinet, connect to power and network, check and update firmware to the latest levels, verify operation, and dispose of the packaging, allowing customers to focus on other priorities.
- **Deployment Services**
  When investing in new IT infrastructures, customers need to ensure that their business will see quick time to value with little to no disruption. Lenovo deployments are designed by development and engineering teams who know Lenovo products and solutions better than anyone else, and Lenovo technicians own the process from delivery to completion. Lenovo will conduct remote preparation and planning, configure and integrate systems, validate systems, verify and update appliance firmware, train on administrative tasks, and provide post-deployment documentation. Customer's IT teams leverage Lenovo skills to enable IT staff to transform with higher level roles and tasks.
- **Integration, Migration, and Expansion Services**
  Integration, Migration, and Expansion Services allow to move existing physical and virtual workloads easily, or to determine technical requirements to support increased workloads while maximizing performance. These services include tuning, validation, and documenting ongoing run processes, and they leverage migration assessment planning documents to perform necessary migrations.

Some service options may not be available in every region. For more information about Lenovo service offerings that are available in a specific region, contact a local Lenovo sales representative or business partner.

Regulatory compliance

The ThinkSystem DM Series enclosures conform to the following regulations:

- United States: FCC Part 15, Class A; UL 60950-1
- Canada: ICES-003, Class A; CAN/CSA-C22.2 60950-1
- Mexico NOM
- European Union: CE Mark (EN55032 Class A, EN55024, IEC/EN60950-1); ROHS Directive 2011/65/EU
- Russia, Kazakhstan, Belarus: EAC
- China: CCC GB 4943.1, GB 17625.1, GB 9254 Class A; CELP; CECP
- Japan: VCCI, Class A
- Taiwan: BSMI CNS 13438, Class A; CNS 14336-1
- Korea KN32/35, Class A
- Australia/New Zealand: AS/NZS CISPR 22 Class A

Interoperability

Lenovo provides end-to-end storage compatibility testing to deliver interoperability throughout the network. The ThinkSystem DM5000F Unified Flash Storage Array supports attachment to Lenovo ThinkSystem, System x, ThinkServer, and Flex System hosts by using NAS (NFS and CIFS/SMB), iSCSI, and Fibre Channel storage connectivity protocols. Hybrid storage connectivity also is supported.

For end-to-end storage configuration support, refer to the Lenovo ThinkSystem DM Series Interoperability Matrix that can be found on the ThinkSystem DM5000F Documentation page on the Lenovo Data Center Support web site:
http://datacentersupport.lenovo.com/us/en/products/storage/lenovo-storage/thinksystem-dm5000f/documentation/userguide

The following sections list adapters and Ethernet LAN and FC SAN switches that are currently offered by Lenovo that can be used with the ThinkSystem DM5000F Flash Storage Array in IT solutions:

- Adapters
- Ethernet LAN switches
- Fibre Channel SAN switches

Note: Tables that are provided in these sections are for ordering reference purposes only. End-to-end storage configuration support *must* be verified through the Lenovo ThinkSystem DM5000F Interoperability Matrix.

Adapters

This section lists the adapters for the following types of storage connectivity:

- NAS and iSCSI connectivity
- Fibre Channel connectivity

NAS and iSCSI connectivity

The ThinkSystem DM5000F supports NAS and iSCSI attachments via standard 1 Gb and 10 Gb Ethernet connections (direct attach or switch-based). Any compatible Ethernet switch, including Lenovo ThinkSystem and RackSwitch Ethernet switches and embedded Flex System Ethernet I/O modules, can be used to provide NAS and iSCSI connectivity for the ThinkSystem DM5000F storage.

With software iSCSI initiators, any supported 1 Gb or 10 Gb Ethernet adapter for Lenovo servers is compatible with the ThinkSystem DM5000F NAS and iSCSI storage.

Fibre Channel connectivity

The ThinkSystem DM5000F supports FC switch-based attachments. Lenovo B Series and DB Series FC SAN switches and directors can be used to provide FC connectivity.

Currently available FC adapters for Lenovo servers that are compatible with the ThinkSystem DM5000F FC storage are listed in the following table. Other FC HBAs also might be supported (see the Interoperability Matrix for details).

Table 14. Fibre Channel adapters

Description	Part number
ThinkSystem HBAs: 32 Gb FC (8/16/32 Gb FC connectivity)	
ThinkSystem Emulex LPe35000 32Gb 1-port PCIe Fibre Channel Adapter	4XC7A08250
ThinkSystem Emulex LPe35002 32Gb 2-port PCIe Fibre Channel Adapter	4XC7A08251
ThinkSystem Emulex LPe32000-M6-LP PCIe 32Gb 1-Port SFP+ Fibre Channel Adapter	7ZT7A00517
ThinkSystem Emulex LPe32002-M6-LP PCIe 32Gb 2-Port SFP+ Fibre Channel Adapter	7ZT7A00519
ThinkSystem QLogic QLE2740 PCIe 32Gb 1-Port SFP+ Fibre Channel Adapter	7ZT7A00516
ThinkSystem QLogic QLE2742 PCIe 32Gb 2-Port SFP+ Fibre Channel Adapter	7ZT7A00518
System x HBAs: 16 Gb FC	
Emulex 16Gb Gen6 FC Single-port HBA (LPe31000)	01CV830
Emulex 16Gb Gen6 FC Dual-port HBA (LPe31002)	01CV840
Emulex 16Gb FC Single-port HBA (LPe16000)	81Y1655
Emulex 16Gb FC Dual-port HBA (LPe16002)	81Y1662
QLogic 16Gb Enhanced Gen5 FC Single-port HBA (QLE2690)	01CV750
QLogic 16Gb Enhanced Gen5 FC Dual-port HBA (QLE2692)	01CV760
QLogic 16Gb FC Single-port HBA (QLE2660)	00Y3337

Description	Part number
QLogic 16Gb FC Dual-port HBA (QLE2662)	00Y3341
Flex System HBAs: 16 Gb FC	
ThinkSystem Emulex LPm16002B-L Mezz 16Gb 2-Port Fibre Channel Adapter	7ZT7A00521
ThinkSystem Emulex LPm16004B-L Mezz 16Gb 4-Port Fibre Channel Adapter	7ZT7A00522
ThinkSystem QLogic QML2692 Mezz 16Gb 2-Port Fibre Channel Adapter	7ZT7A00520

Ethernet LAN switches

The following table lists currently available rack-mount Ethernet switches that are currently offered by Lenovo that can be used with the ThinkSystem DM5000F Unified Flash Storage Array in IT solutions.

Table 15. Ethernet rack-mount switches

Description	Part number
1 Gb Ethernet (1 GbE connectivity; NAS and iSCSI)	
Lenovo ThinkSystem NE0152T RackSwitch (Rear to Front)	7Y810011WW
Lenovo ThinkSystem NE0152TO RackSwitch (Rear to Front, ONIE)	7Z320O11WW
Lenovo RackSwitch G7028 (Rear to Front)	7159BAX
Lenovo RackSwitch G7052 (Rear to Front)	7159CAX
Lenovo CE0128TB Switch (3-Year Warranty)	7Z340011WW
Lenovo CE0128TB Switch (Limited Lifetime Warranty)	7Z360011WW
Lenovo CE0128PB Switch (3-Year Warranty)	7Z340012WW
Lenovo CE0128PB Switch (Limited Lifetime Warranty)	7Z360012WW
Lenovo CE0152TB Switch (3-Year Warranty)	7Z350021WW
Lenovo CE0152TB Switch (Limited Lifetime Warranty)	7Z370021WW
Lenovo CE0152PB Switch (3-Year Warranty)	7Z350022WW
Lenovo CE0152PB Switch (Limited Lifetime Warranty)	7Z370022WW
10 Gb Ethernet (10 GbE connectivity; NAS and iSCSI)	
Lenovo ThinkSystem NE1032 RackSwitch (Rear to Front)	7159A1X
Lenovo ThinkSystem NE1032T RackSwitch (Rear to Front)	7159B1X
Lenovo ThinkSystem NE1064TO RackSwitch (Rear to Front, ONIE)	7Z330O11WW
Lenovo ThinkSystem NE1072T RackSwitch (Rear to Front)	7159C1X
Lenovo RackSwitch G8272 (Rear to Front)	7159CRW
25 Gb Ethernet (10 GbE connectivity out of an SFP28 port; NAS and iSCSI)	
Lenovo ThinkSystem NE2572 RackSwitch (Rear to Front)	7159E1X
Lenovo ThinkSystem NE2572O RackSwitch (Rear to Front, ONIE)	7Z210O21WW
Lenovo ThinkSystem NE2580O RackSwitch (Rear to Front, ONIE)	7Z330O21WW
100 Gb Ethernet (4x 10 GbE breakout connectivity out of a QSFP28 port; NAS and iSCSI)	
Lenovo ThinkSystem NE10032 RackSwitch (Rear to Front)	7159D1X
Lenovo ThinkSystem NE10032O RackSwitch (Rear to Front, ONIE)	7Z210O11WW

For more information, see the list of Product Guides in the Top-of-rack Switches category:
http://lenovopress.com/servers/options/switches#rt=product-guide

The following table lists currently available embedded Ethernet switches and pass-thru modules for Flex System that can be used with the ThinkSystem DM5000F Unified Flash Storage Array in IT solutions.

Table 16. Embedded Ethernet switches for Flex System

Description	Part number
10 Gb Ethernet (10 GbE connectivity; NAS and iSCSI)	
Lenovo Flex System Fabric EN4093R 10Gb Scalable Switch	00FM514
Lenovo Flex System SI4091 10Gb System Interconnect Module	00FE327
Lenovo Flex System Fabric SI4093 System Interconnect Module	00FM518
25 Gb Ethernet (10 GbE connectivity out of an SFP28 port; NAS and iSCSI)	
Lenovo ThinkSystem NE2552E Flex Switch	4SG7A08868
Pass-thru modules (10 GbE connectivity [require a compatible external switch]; NAS and iSCSI)	
Lenovo Flex System EN4091 10Gb Ethernet Pass-thru	88Y6043

For more information, see the list of Product Guides in the Blade Network Modules category:
http://lenovopress.com/servers/blades/networkmodule#rt=product-guide

Fibre Channel SAN switches

The following table lists currently available rack-mount Fibre Channel SAN switches that are offered by Lenovo that can be used with the ThinkSystem DM5000F Unified Flash Storage Array in IT solutions.

Table 17. Rack-mount Fibre Channel SAN switches

Description	Part number
16 Gb FC	
Lenovo ThinkSystem DB610S, 8 ports licensed, 8x 16Gb SWL SFPs, 1 PS, Rail Kit, 1Yr FW	6559F2A
Lenovo ThinkSystem DB610S, ENT., 24 ports licensed, 24x 16Gb SWL SFPs, 1 PS, Rail Kit, 1Yr FW	6559F1A
Lenovo ThinkSystem DB620S, 24 ports licensed, 24x 16Gb SWL SFPs, 2 PS, Rail Kit, 1Yr FW	6415J1A
Lenovo B6505, 12 ports licensed, 12x 16Gb SWL SFPs, 1 PS, Rail Kit, 1Yr FW	3873ER1
Lenovo B6510, 24 ports licensed, 24x 16Gb SWL SFPs, 2 PS, Rail Kit, 1Yr FW	3873IR1
Lenovo B6510, 24 ports licensed, 24x 16Gb SWL SFPs, 2 PS, Rail Kit, 3Yr FW	3873BR3
32 Gb FC	
Lenovo ThinkSystem DB610S, 8 ports licensed, No SFPs, 1 PS, Rail Kit, 1Yr FW	6559F3A
Lenovo ThinkSystem DB620S, 24 ports licensed, No SFPs, 2 PS, Rail Kit, 1Yr FW	6415G3A
Lenovo ThinkSystem DB620S, 24 ports licensed, 24x 32Gb SWL SFPs, 2 PS, Rail Kit, 1Yr FW	6415H11
Lenovo ThinkSystem DB620S, ENT., 48 ports licensed, 48x 32Gb SWL SFPs, 2 PS, Rail Kit, 1Yr FW	6415H2A
Lenovo ThinkSystem DB630S, 48 ports licensed, No SFPs, 2 PS, Rail Kit, 1Yr FW	7D1SA001WW
Lenovo ThinkSystem DB630S, 48 ports licensed, 48x 32Gb SWL SFPs, 2 PS, Rail Kit, 1Yr FW	7D1SA002WW
Lenovo ThinkSystem DB630S, ENT., 96 ports licensed, 96x 32Gb SWL SFPs, 2 PS, Rail Kit, 1Yr FW	7D1SA003WW
Lenovo ThinkSystem DB400D 32Gb FC Director, ENT., 4 Blade slots, 8U, 1Yr FW	6684D2A
Lenovo ThinkSystem DB400D 32Gb FC Director, ENT., 4 Blade slots, 8U, 3Yr FW	6684B2A
Lenovo ThinkSystem DB800D 32Gb FC Director, ENT., 8 Blade slots, 14U, 1Yr FW	6682D1A

For more information, see the list of Product Guides in the Rack SAN Switches category:
http://lenovopress.com/storage/switches/rack#rt=product-guide

The following table lists currently available embedded Fibre Channel SAN switches for Flex System that can be used with the ThinkSystem DM5000F Unified Flash Storage Array in IT solutions.

Table 18. Embedded FC SAN switches for Flex System

Description	Part number
16 Gb FC	
Lenovo Flex System FC5022 16Gb SAN Scalable Switch	88Y6374
Lenovo Flex System FC5022 24-port 16Gb SAN Scalable Switch (includes two 16 Gb SFPs)	00Y3324
Lenovo Flex System FC5022 24-port 16Gb ESB SAN Scalable Switch	90Y9356

For more information, see the list of Product Guides in the Blade Storage Modules category:
http://lenovopress.com/servers/blades/storagemodule#rt=product-guide

Operating systems

The ThinkSystem DM5000F supports host attachments to the Lenovo servers running the following operating systems:

- Microsoft:
  - Microsoft Windows Server 2019
  - Microsoft Windows Server 2016
  - Microsoft Windows Server 2012 R2
- Red Hat:
  - Red Hat Enterprise Linux 8
  - Red Hat Enterprise Linux 7 Update 7
  - Red Hat Enterprise Linux 7 Update 6
  - Red Hat Enterprise Linux 7 Update 5
  - Red Hat Enterprise Linux 6 Update 10
  - Red Hat Enterprise Linux 6 Update 9
  - Red Hat Enterprise Linux 6 Update 8
- SUSE:
  - SUSE Linux Enterprise Server 15 SP1
  - SUSE Linux Enterprise Server 15
  - SUSE Linux Enterprise Server 12 SP4
  - SUSE Linux Enterprise Server 12 SP3
  - SUSE Linux Enterprise Server 11 SP4
  - SUSE Linux Enterprise Server 11 SP3
- VMware:
  - VMware vSphere 6.7 Update 3
  - VMware vSphere 6.7 Update 2
  - VMware vSphere 6.7 Update 1
  - VMware vSphere 6.7
  - VMware vSphere 6.5 Update 3
  - VMware vSphere 6.5 Update 2
  - VMware vSphere 6.5 Update 1
  - VMware vSphere 6.0 Update 3
  - VMware vSphere 6.0 Update 2
  - VMware vSphere 6.0 Update 1

Rack cabinets

The following table lists the rack cabinets that are offered by Lenovo that can be used with the ThinkSystem DM5000F Unified Flash Storage Array in IT solutions.

Table 19. Rack cabinets

Description	Part number
25U S2 Standard Rack (1000 mm deep; 2 sidewall compartments)	93072RX
25U Static S2 Standard Rack (1000 mm deep; 2 sidewall compartments)	93072PX
42U S2 Standard Rack (1000 mm deep; 6 sidewall compartments)	93074RX
42U 1100mm Enterprise V2 Dynamic Rack (6 sidewall compartments)	93634PX
42U 1100mm Enterprise V2 Dynamic Expansion Rack (6 sidewall compartments)	93634EX
42U 1200mm Deep Dynamic Rack (6 sidewall compartments)	93604PX
42U 1200mm Deep Static Rack (6 sidewall compartments)	93614PX
42U Enterprise Rack (1105 mm deep; 4 sidewall compartments)	93084PX
42U Enterprise Expansion Rack (1105 mm deep; 4 sidewall compartments)	93084EX

For more information, see the list of Product Guides in the Rack cabinets category:
http://lenovopress.com/servers/options/racks#rt=product-guide

Power distribution units

The following table lists the power distribution units (PDUs) that are offered by Lenovo that can be used for distributing electrical power to the ThinkSystem DM5000F Unified Flash Storage Array and other IT infrastructure building blocks mounted in a rack cabinet.

Table 20. Power distribution units

Description	Part number
0U Basic PDUs	
0U 36 C13/6 C19 24A/200-240V 1 Phase PDU with NEMA L6-30P line cord	00YJ776
0U 36 C13/6 C19 32A/200-240V 1 Phase PDU with IEC60309 332P6 line cord	00YJ777
0U 21 C13/12 C19 32A/200-240V/346-415V 3 Phase PDU with IEC60309 532P6 line cord	00YJ778
0U 21 C13/12 C19 48A/200-240V 3 Phase PDU with IEC60309 460P9 line cord	00YJ779
Switched and Monitored PDUs	
0U 20 C13/4 C19 Switched and Monitored 24A/200-240V/1Ph PDU w/ NEMA L6-30P line cord	00YJ781
0U 20 C13/4 C19 Switched and Monitored 32A/200-240V/1Ph PDU w/ IEC60309 332P6 line cord	00YJ780
0U 18 C13/6 C19 Switched / Monitored 32A/200-240V/346-415V/3Ph PDU w/ IEC60309 532P6 cord	00YJ782
0U 12 C13/12 C19 Switched and Monitored 48A/200-240V/3Ph PDU w/ IEC60309 460P9 line cord	00YJ783
1U 9 C19/3 C13 Switched and Monitored DPI PDU (without line cord)	46M4002
1U 9 C19/3 C13 Switched and Monitored 60A 3Ph PDU with IEC 309 3P+Gnd cord	46M4003
1U 12 C13 Switched and Monitored DPI PDU (without line cord)	46M4004
1U 12 C13 Switched and Monitored 60A 3 Phase PDU with IEC 309 3P+Gnd line cord	46M4005
Ultra Density Enterprise PDUs (9x IEC 320 C13 + 3x IEC 320 C19 outlets)	
Ultra Density Enterprise C19/C13 PDU Module (without line cord)	71762NX

Description	Part number
Ultra Density Enterprise C19/C13 PDU 60A/208V/3ph with IEC 309 3P+Gnd line cord	71763NU
C13 Enterprise PDUs (12x IEC 320 C13 outlets)	
DPI C13 Enterprise PDU+ (without line cord)	39M2816
DPI Single Phase C13 Enterprise PDU (without line cord)	39Y8941
C19 Enterprise PDUs (6x IEC 320 C19 outlets)	
DPI Single Phase C19 Enterprise PDU (without line cord)	39Y8948
DPI 60A 3 Phase C19 Enterprise PDU with IEC 309 3P+G (208 V) fixed line cord	39Y8923
Front-end PDUs (3x IEC 320 C19 outlets)	
DPI 30amp/125V Front-end PDU with NEMA L5-30P line cord	39Y8938
DPI 30amp/250V Front-end PDU with NEMA L6-30P line cord	39Y8939
DPI 32amp/250V Front-end PDU with IEC 309 2P+Gnd line cord	39Y8934
DPI 60amp/250V Front-end PDU with IEC 309 2P+Gnd line cord	39Y8940
DPI 63amp/250V Front-end PDU with IEC 309 2P+Gnd line cord	39Y8935
Universal PDUs (7x IEC 320 C13 outlets)	
DPI Universal 7 C13 PDU (with 2 m IEC 320-C19 to C20 rack power cord)	00YE443
NEMA PDUs (6x NEMA 5-15R outlets)	
DPI 100-127V PDU with fixed NEMA L5-15P line cord	39Y8905
Line cords for PDUs that ship without a line cord	
DPI 30a Line Cord (NEMA L6-30P)	40K9614
DPI 32a Line Cord (IEC 309 P+N+G)	40K9612
DPI 32a Line Cord (IEC 309 3P+N+G)	40K9611
DPI 60a Cord (IEC 309 2P+G)	40K9615
DPI 63a Cord (IEC 309 P+N+G)	40K9613
DPI Australian/NZ 3112 Line Cord (32A)	40K9617
DPI Korean 8305 Line Cord (30A)	40K9618

For more information, see the list of Product Guides in the PDU category:
http://lenovopress.com/servers/options/pdu#rt=product-guide

Uninterruptible power supply units

The following table list the uninterruptible power supply (UPS) units that are currently offered by Lenovo that can be used with the ThinkSystem DM5000F Unified Flash Storage Array in IT solutions.

Table 21. Uninterruptible power supply units

Description	Part number
Worldwide models	
RT1.5kVA 2U Rack or Tower UPS (100-125VAC) (8x NEMA 5-15R 12A outlets)	55941AX
RT1.5kVA 2U Rack or Tower UPS (200-240VAC) (8x IEC 320 C13 10A outlets)	55941KX
RT2.2kVA 2U Rack or Tower UPS (100-125VAC) (8x NEMA 5-20R 16A outlets)	55942AX
RT2.2kVA 2U Rack or Tower UPS (200-240VAC) (8x IEC 320 C13 10A, 1x IEC 320 C19 16A outlets)	55942KX
RT3kVA 2U Rack or Tower UPS (100-125VAC) (6x NEMA5-20R 16A, 1x NEMA L5-30R 24A outlets)	55943AX
RT3kVA 2U Rack or Tower UPS (200-240VAC) (8x IEC 320 C13 10A, 1x IEC 320 C19 16A outlets)	55943KX
RT5kVA 3U Rack or Tower UPS (200-240VAC) (8x IEC 320 C13 10A, 2x IEC 320 C19 16A outlets)	55945KX
RT6kVA 3U Rack or Tower UPS (200-240VAC) (8x IEC 320 C13 10A, 2x IEC 320 C19 16A outlets)	55946KX
RT8kVA 6U Rack or Tower UPS (200-240VAC) (4x IEC 320-C19 16A outlets)	55948KX
RT11kVA 6U Rack or Tower UPS (200-240VAC) (4x IEC 320-C19 16A outlets)	55949KX
RT8kVA 6U 3:1 Phase Rack or Tower UPS (380-415VAC) (4x IEC 320-C19 16A outlets)	55948PX
RT11kVA 6U 3:1 Phase Rack or Tower UPS (380-415VAC) (4x IEC 320-C19 16A outlets)	55949PX
ASEAN, HTK, INDIA, and PRC models	
ThinkSystem RT3kVA 2U Standard UPS (200-230VAC) (2x C13 & 2x GB 10A, 1x C19 16A outlets)	55943KT
ThinkSystem RT3kVA 2U Long Backup UPS (200-230VAC) (2x C13 & 2x GB 10A, 1x C19 16A outlets)	55943LT
ThinkSystem RT6kVA 5U UPS (200-230VAC) (2x C13 10A outlets, 1x Terminal Block output)	55946KT
ThinkSystem RT10kVA 5U UPS (200-230VAC) (2x C13 10A outlets, 1x Terminal Block output)	5594XKT

For more information, see the list of Product Guides in the Uninterruptible Power Supply Units category: http://lenovopress.com/servers/options/ups#rt=product-guide

Lenovo Financial Services

Lenovo Financial Services reinforces Lenovo's commitment to deliver pioneering products and services that are recognized for their quality, excellence, and trustworthiness. Lenovo Financial Services offers financing solutions and services that complement your technology solution anywhere in the world.

We are dedicated to delivering a positive finance experience for customers like you who want to maximize your purchase power by obtaining the technology you need today, protect against technology obsolescence, and preserve your capital for other uses.

We work with businesses, non-profit organizations, governments and educational institutions to finance their entire technology solution. We focus on making it easy to do business with us. Our highly experienced team of finance professionals operates in a work culture that emphasizes the importance of providing outstanding customer service. Our systems, processes and flexible policies support our goal of providing customers with a positive experience.

We finance your entire solution. Unlike others, we allow you to bundle everything you need from hardware and software to service contracts, installation costs, training fees, and sales tax. If you decide weeks or months later to add to your solution, we can consolidate everything into a single invoice.

Our Premier Client services provide large accounts with special handling services to ensure these complex transactions are serviced properly. As a premier client, you have a dedicated finance specialist who manages your account through its life, from first invoice through asset return or purchase. This specialist develops an in-depth understanding of your invoice and payment requirements. For you, this dedication provides a high-quality, easy, and positive financing experience.

For more information about your region-specific offers, contact your Lenovo sales representative or your technology provider about the use of Lenovo Financial Services. For more information, see the following Lenovo website:
http://www.lenovo.com/us/en/landingpage/lenovo-financial-services

Related publications and links

For more information, see the following resources:

- Lenovo Data Center SAN Storage product page
  http://www.lenovo.com/us/en/c/storage-area-network
- Lenovo Data Center Solution Configurator
  http://dcsc.lenovo.com
- ThinkSystem DM Series documentation
  http://thinksystem.lenovofiles.com/storage/help/topic/ontap_software/overview.html
- Lenovo Data Center Support - ThinkSystem DM5000F
  http://datacentersupport.lenovo.com/us/en/products/storage/lenovo-storage/thinksystem-dm5000f

Related product families

Product families related to this document are the following:

- DM Series Storage
- Lenovo Storage
- External Storage

Notices

Lenovo may not offer the products, services, or features discussed in this document in all countries. Consult your local Lenovo representative for information on the products and services currently available in your area. Any reference to a Lenovo product, program, or service is not intended to state or imply that only that Lenovo product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any Lenovo intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any other product, program, or service. Lenovo may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

Lenovo (United States), Inc.
1009 Think Place - Building One
Morrisville, NC 27560
U.S.A.
Attention: Lenovo Director of Licensing

LENOVO PROVIDES THIS PUBLICATION ”AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some jurisdictions do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. Lenovo may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

The products described in this document are not intended for use in implantation or other life support applications where malfunction may result in injury or death to persons. The information contained in this document does not affect or change Lenovo product specifications or warranties. Nothing in this document shall operate as an express or implied license or indemnity under the intellectual property rights of Lenovo or third parties. All information contained in this document was obtained in specific environments and is presented as an illustration. The result obtained in other operating environments may vary. Lenovo may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Any references in this publication to non-Lenovo Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this Lenovo product, and use of those Web sites is at your own risk. Any performance data contained herein was determined in a controlled environment. Therefore, the result obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

This document, LP0911, was created or updated on March 9, 2020.

Send us your comments in one of the following ways:

- Use the online Contact us review form found at:
  http://lenovopress.com/LP0911
- Send your comments in an e-mail to:
  comments@lenovopress.com

This document is available online at http://lenovopress.com/LP0911.

Trademarks

Lenovo and the Lenovo logo are trademarks or registered trademarks of Lenovo in the United States, other countries, or both. A current list of Lenovo trademarks is available on the Web at https://www.lenovo.com/us/en/legal/copytrade/.

The following terms are trademarks of Lenovo in the United States, other countries, or both:
AnyFabric®
Flex System
Lenovo Services
Lenovo®
RackSwitch
System x®
ThinkServer®
ThinkSystem
XClarity®

The following terms are trademarks of other companies:

Linux® is the trademark of Linus Torvalds in the U.S. and other countries.

Internet Explorer®, Microsoft®, Windows Server®, and Windows® are trademarks of Microsoft Corporation in the United States, other countries, or both.

Other company, product, or service names may be trademarks or service marks of others.

StorageX

DATA DYNAMICS
Manage Your Data®

STORAGEX® 8.0
Dynamic File Management™

ELEVATOR PITCH

Data Dynamics provides intelligent file management to enable agile discovery, analysis, management and migration of unstructured file data across proprietary file storage types, including S3 cloud object storage.

PRODUCT QUICK FACTS

StorageX dynamic file management platform empowers you to analyze, move, manage and modernize your data where you need it and when you need it, from your data center to the cloud.

- Built using industry standards; supports all standard protocols (NFS, SMB, S3 Object)
- Operates completely out of the data path, no vendor lock-in.
- Move files from NAS to NAS and NAS to Object and avoid the technology lock-in that results from product that operate in the data path.
- Powerful integrated file analytics scan filesystems to gather meta information.
- Automated policy-based movement cuts migration time in half and reduces errors.
- Add custom tags and meta information to mange files for archiving and optimization.
- New file-to-object conversion supports new software-defined storage platforms.
- Modernize applications to directly access object files via the StorageX Developer APIs.

TARGET MARKETS

The ubiquitous nature of unstructured files means that StorageX is not limited to a specific vertical industry. Primary markets are:

- Regulated industries (financial, healthcare, insurance)
- Government and public sector
- Energy

SOLUTION SPECIFICS

USE CASES

Filesystem Analysis and Categorization
Using StorageX you can dive deeply into your storage resources to uncover decision making information. Use the scanned file data to drive automated, file movement and archival policies.

Technology Refresh
Automated data movement policies facilitate the transfer, or migration, of SMB/NFS source files to across heterogenous storage resources. Move an entire share or export to a new share or export.

Filesystem Restructuring
Provision heterogeneous file storage resources: CIFS shared folders, NFS Exports, Data ONTAP volumes, qtrees and SNAPMirrors. For S3 compliant storage, StorageX can provision S3 buckets.

IT Service Integration
StorageX RESTful API gives you programmatic control over its file management functions. Use the StorageX API in your custom application to perform StorageX tasks without the StorageX Console.

File Archiving and Cloud Tiering
Use StorageX to convert files to S3-compliant object storage and move to cloud or alternative storage location for long-term retention, archival and optimization.

Microsoft DFS Namespace Management
Use StorageX DFS management capabilities to synchronize, backup/restore or merge namespace configuration information. Convert stand-alone namespace to domain-based.

File Security Compliance
Use StorageX to scan your file systems and fix security issues: copy file permissions and ACLs, clone permissions for shares/exports, delete share permissions and export policies, remove invalid SIDs.

TARGET PERSONAS

- CIO/CTO, IT Manager/Director
- System and Storage Administrator
- Legal Department/General Counsel
- Chief Regulatory/Compliance Officer

DRIVERS/BENEFITS

CUSTOMER BENEFITS

- Reduce storage-related operational costs 50%
- Deploy new storage technology 66% faster
- Modernize applications for 10X productivity improvement

PARTNER BENEFITS

- Faster on-ramp to new storage means shorter time to next sale
- Drive consumption of all tiers of storage
- Value added, flexible delivery model (increased services revenue)
- Consumption-based price model
- Improve competitiveness

STORAGEX PROOF POINTS

- 6 of 12 world's largest banks
- 24 of Fortune 100 companies
- 15 years – time tested, customer proven
- 200+ PB total data moved and managed
- 100+ years total project time saved
- 100+ MM total storage cost savings

MORE INFORMATION
https://www.datadynamicsinc.com/resources/

ABOUT DATA DYNAMICS INC.

Data Dynamics, Inc.
Founded 2012
Offices in NJ (HQ), Houston, TX
Core Technology: File Management

Contact Sales at:
sales@datdyn.com

Visit our website at:
https://www.datadynamicsinc.com/

Storage X

Data Management Software

Data Dynamics

DATA DYNAMICS
Manage Your Data®

DATA DYNAMICS

Manage Your Data®

TRUSTED

26
Fortune 100 Companies

6 of 12
World's Largest Banks

PROVEN

17 Years
Time Tested Customer Proven

350+ PB
Storage Optimized

300+
Enterprise Customers

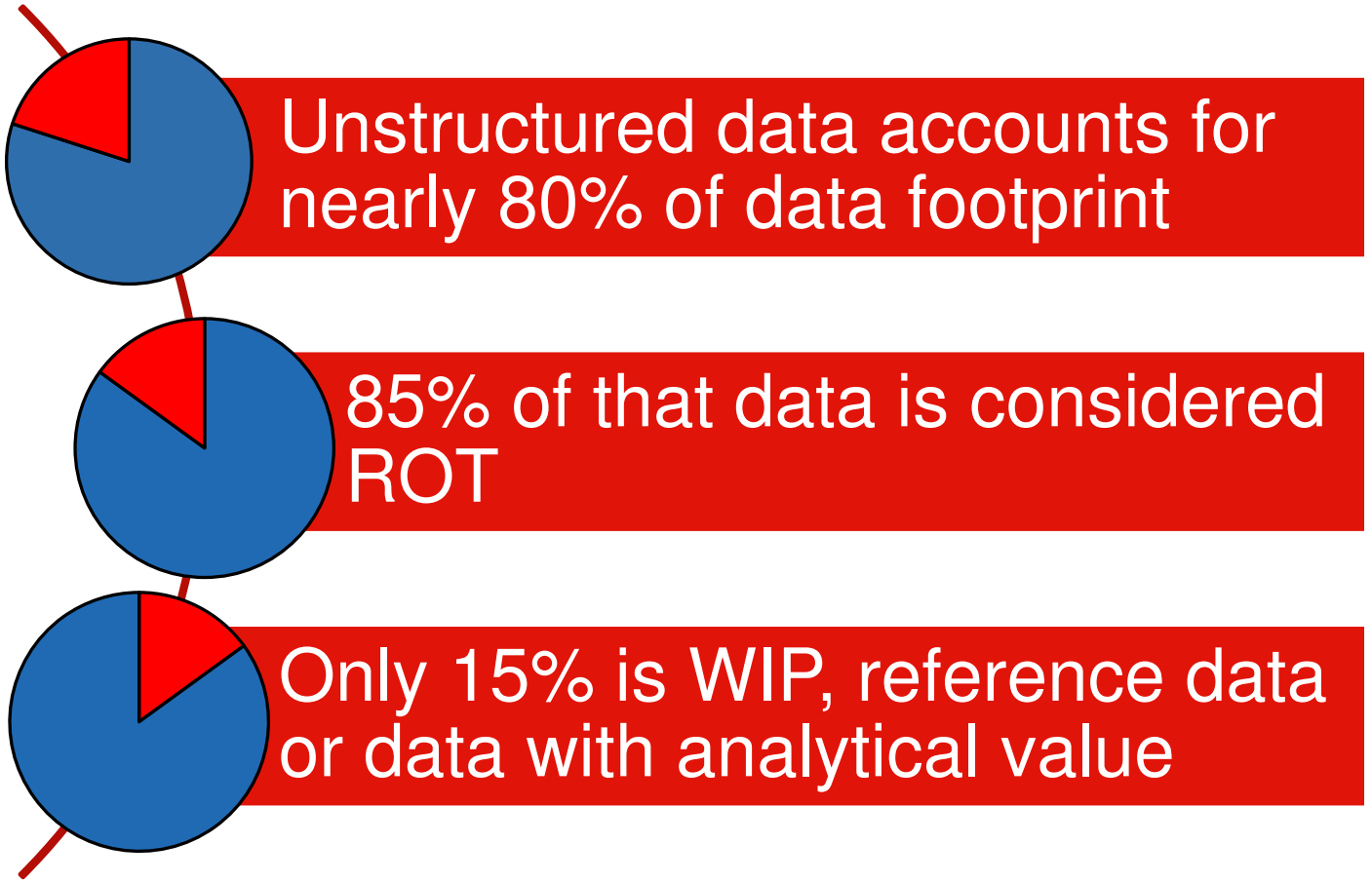
IMPACT

170+ Years
Project Time Saved

$250+ MM
Total Cost of Storage Saved

Globally Deployed and Proven

Gartner Says



Unstructured data accounts for nearly 80% of data footprint

85% of that data is considered ROT

Only 15% is WIP, reference data or data with analytical value

Unstructured Data Management with StorageX

A Software Platform that Drives the Lenovo Infrastructure

Analytic insights enables "Manage, Move & Protect" solution designs!

Analyze

- Metadata Analytics
- Content Analytics
- Categorization & Tagging

Data movement enables competitive take outs, reduces backup costs, accelerates adoption of Lenovo Cloud Solutions

Move

- Replication/Synch
- Archive
- Migration

Data Management delivers proactive, automated and policy driven results.

Manage

- DFS Management
- Policy Automation
- Reporting
- Monitoring/Alerting
- RESTful API Support
- Privacy Risk Classifier

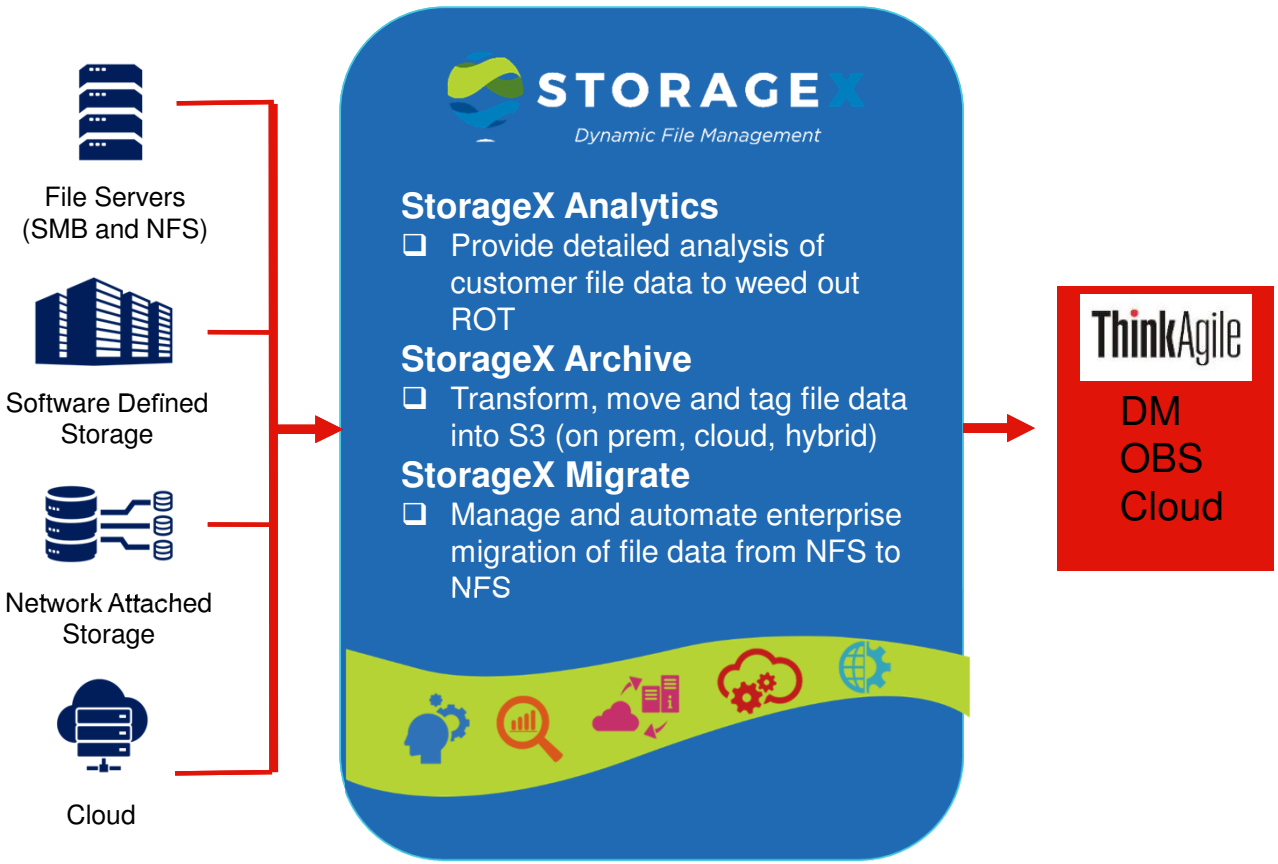
Eliminate legacy roadblocks to Lenovo's Infrastructure

Modernize

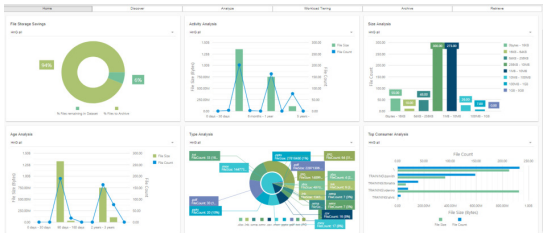
- Migrate EMC to DM
- Enable Cloud
- Archive to Object Storage
- Provide Analytics

STORAGEX
Dynamic File Management™

StorageX Solution Set



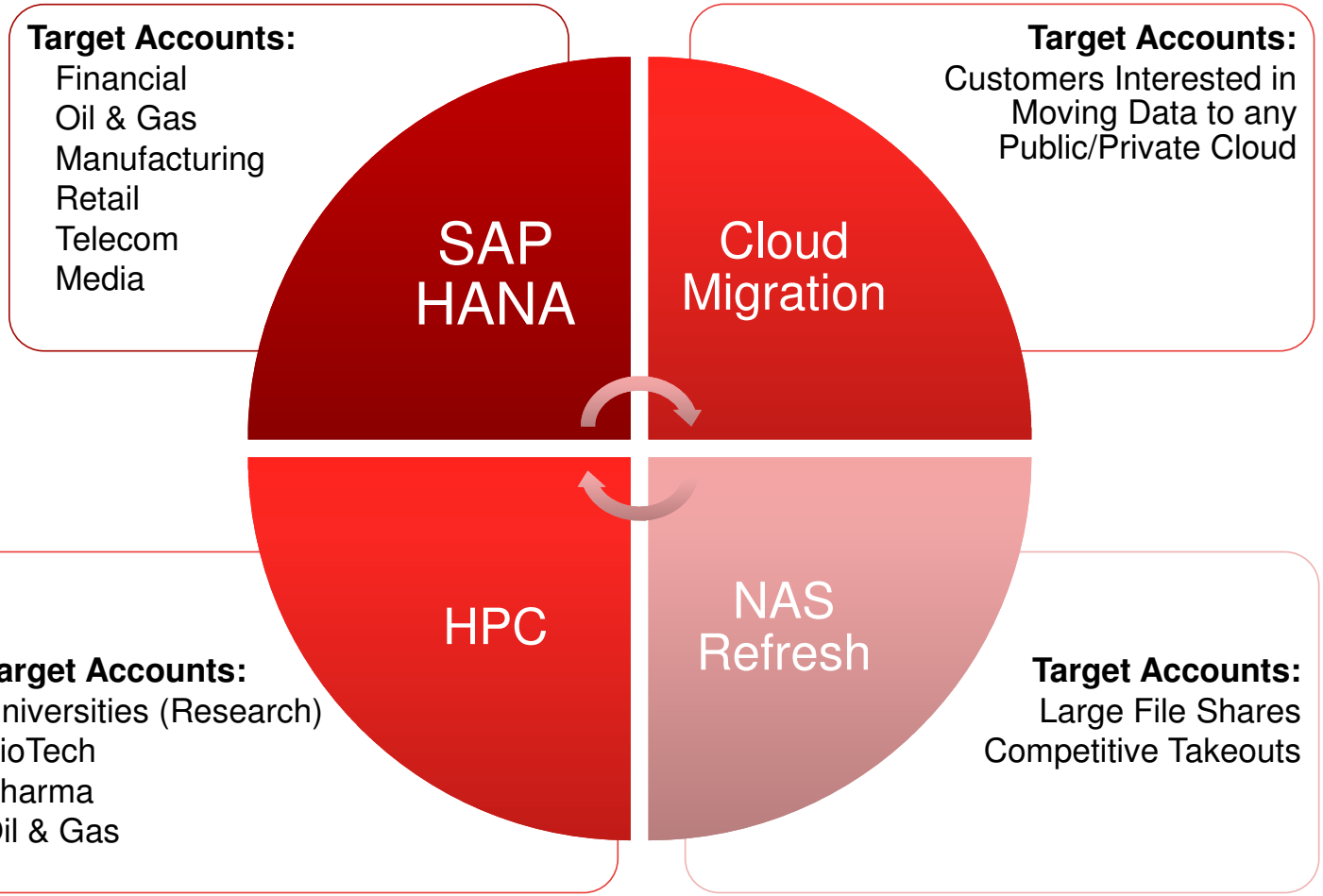
StorageX Analytics provides in-depth hardware and file system information to manage your IT business processes.



Here are some challenges that organizations commonly face:

- **Changing storage vendors?** How do I collect details about the current hardware infrastructure?
- **Merging with another company?** How do I merge namespaces into a new coherent model?
- **Employee layoffs?** How do I protect file shares that previous employees had access to?

Data Dynamics – Use Cases



Use Case Examples

SAP HANA

- Identify the right data to be used in SAP HANA environments and move it to the right place
- Cloud play – replicate change logs vs full replication for cloud DR scenarios saving major bandwidth costs

Cloud Migration

- Cloud migration and replication can be used to provide an easy way for customers to deploy hybrid cloud strategies
- Strategically move the right data using analytics to select the right data to be moved to the right cloud tier

HPC Deployments

- HPC labs require high performance storage for use in their scratch space and then need a lower cost tier when it is not being used.
- Intelligent archiving/tiering using analytics can efficiently move the right data where it needs to go to dramatically lower costs

Competitive Takeout

- Use StorageX Migration to quickly and efficiently move data off of any NFS/CIFS device during a tech refresh
- Enterprise performance, scaling and automation ensure the migration is completed on time with less resources

DATA DYNAMICS
Manage Your Data®

Gartner peerinsights™

Reviewer Profile

Sr Officer Products Imp.

Industry:
Finance

Role:
Sales and Marketing

Firm Size:
3B - 10B USD

Implementation Strategy:
Worked with just the vendor

"Best Digital File Management Tool For Huge Data Set"

Submitted: December 20, 2019

★★★★☆ **Overall User Rating**

Was this user review helpful?

Product(s): Data Dynamics StorageX

Overall Comment:"StorageX is a dynamic file management is a tool in use by our bank for the purpose of file record keeping and digital organization of files and archiving. To maintain, update and archive the data of our huge customer base, we use a set of solutions and StorageX is a vital part in it."

●●●●●	Evaluation & Contracting	●●●●○	Integration & Deployment
●●●●○	Service & Support	●●●●●	Product Capabilities

Reviewer Profile

Director-Tech Services

Industry:
Services

Role:
Enterprise Architecture and Technology Innovation

Firm Size:
30B + USD

Implementation Strategy:
Worked with just the vendor

"A Real Partner! Good Customer Service In Sales And Support."

Submitted: April 8, 2019

1 of 1 found this review helpful.

★★★★★ **Overall User Rating**

Was this user review helpful?

Product(s): Data Dynamics StorageX

Overall Comment:"A real partner! Good customer service in sales and support. clearly communicated the tools capabilities, they stepped up when we needed customer configs/test to do poc in our environment and suit the tool to our requirements. Really good customer service. "

●●●●●	Evaluation & Contracting	●●●●●	Integration & Deployment
●●●●●	Service & Support	●●●●●	Product Capabilities

What Does StorageX Do for You

- Increase Deal Size
- Improve Customer Value
- Capture Cloud Business
- Take Out Competition

COMPETITIVE TAKEOUT BUNDLES

Dell/EMC to DM **Nutanix to DM** **HPE to DM** **IBM Nseries to DM**

Provides heterogeneous, enterprise class migration reducing time & costs of refresh projects so the customer can consume more Lenovo storage

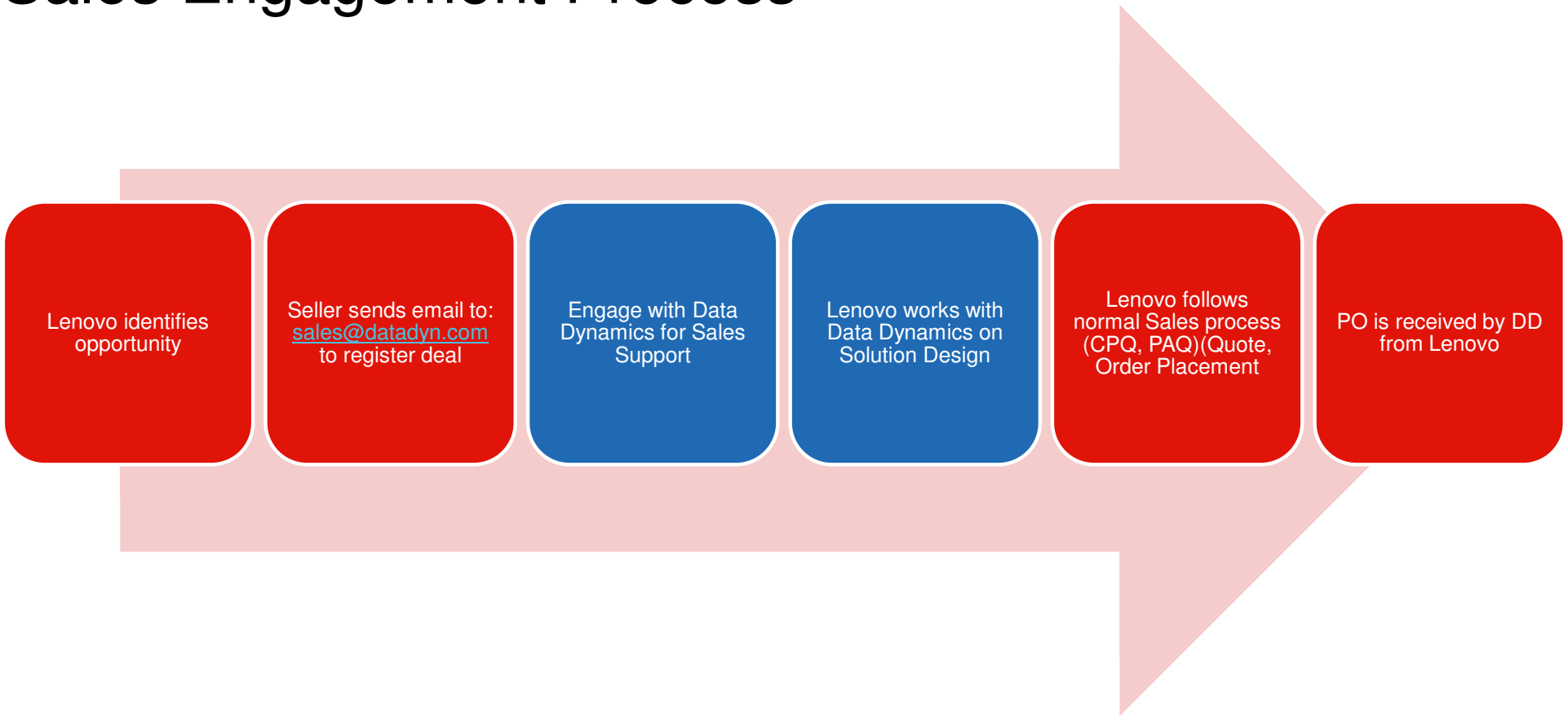
Qty	SKU	Customer Price
50	DDSX8.2 EM-1TB-1Y	$8,403
Data Dynamics Spiff		TBD
Estimated Lenovo AFA Sale (usable)		$140,000

Qty	SKU	Customer Price
250	DDSX8.2 EM-1TB-1Y	$42,016
Data Dynamics Spiff		TBD
Estimated Lenovo AFA Sale (usable)		$650,000

Qty	SKU	Customer Price
100	DDSX8.2 EM-1TB-1Y	$16,806
Data Dynamics Spiff		TBD
Estimated Lenovo AFA Sale (usable)		$260,000

Qty	SKU	Customer Price
500	DDSX8.2 EM-500TB-1Y	$84,033
Data Dynamics Spiff		TBD
Estimated Lenovo AFA Sale (usable)		$1,350,000

Sales Engagement Process



Call to Action: Free Analytics Trial

Free Analytics Trial*

- ❑ No cost trial of StorageX Analytics software
- ❑ Customer can analyze 2 File Shares (limit of 10TBs of storage total)
- ❑ Provides customer with detailed analysis report of environment

* Customer must a qualified opportunity with more than 100 TBs of data in their environment

Contacts

Data Dynamic Support:
Email: sales@datdyn.com
Phone: 713-491-4298

Deal Registration:
Email: Sales@datdyn.com
Info Needed:

- Client Company
- Lenovo Opp Owner/SE
- Key Customer Contact/Organization
- Use Case/Opportunity
- Approximate Size in TB

www.datadynamicsinc.com

For internal Lenovo questions please contact:
kreed1@lenovo.com

Data Dynamics Lenovo Sales Team Members

Lenovo Sales Lead – Dan Dileso daniel.diieso@datdyn.com
DD Partner Mgr – Mike Smith michael.smith@datdyn.com