Lenovo Certified Configurations for Microsoft Azure Stack HCI (S2D)

Last Update: July 2021

Provides detailed views of Lenovo certified configurations for building Azure Stack HCI solutions

Describes the Microsoft Azure Stack HCI Program

Updated for Lenovo ThinkAgile MX Appliances

Updated to show supported GPU adapters

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Abstract

Deploying hyperconverged infrastructure has become the de-facto standard for organizations looking to modernize their aging infrastructure. Large storage deployments are increasingly being replaced by HCI-based solutions for most general-purpose workloads. HCI has proven to deliver better efficiency and price performance in the datacenter. Additionally, customers have been choosing a hybrid approach, migrating certain workloads to the cloud, while keeping other workloads on-premises.

Azure Stack HCI, a new HCI host operating system from Microsoft, is Microsoft's HCI solution for customers who wish to run workloads on-premises and extend easily to Microsoft Azure for hybrid capabilities such as back-up, site recovery, storage, cloud-based monitoring and more. Whether you prefer to deploy the new Azure Stack HCI operating system or take advantage of Azure Stack HCI functional capabilities that are built into Windows Server 2019, Lenovo ThinkAgile MX solutions provide hardware that is certified for use in both scenarios.

The benefits of Lenovo® HCI solutions include:

- Highly available and scale-on-demand compute/storage integrated solutions
- Easy to provision new IT services and reduce deployment time
- Better performance and lower Total Cost of Ownership (TCO)
- Flexible infrastructure and data centers

This document provides background information regarding the Microsoft Windows Server Software-Defined (WSSD) program for Windows Server 2016 and the Microsoft Azure Stack HCI program for Windows Server 2019, as well as the benefits of deploying certified configurations based on Lenovo ThinkAgile™ MX Certified Nodes and Applicances. It also provides details of the current Lenovo certified configurations for Azure Stack HCI, including processor, memory, network, and storage components included with each cluster node.

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Introduction

Lenovo has worked closely with Microsoft for many years to ensure our products perform smoothly and reliably with Microsoft operating systems and software. Our customers can leverage the benefits of our partnership with Microsoft by taking advantage of HCI solutions that have been certified under either the Microsoft Windows Server Software-Defined (WSSD) program for Windows Server 2016 or the Microsoft Azure Stack HCI program for Windows Server 2019.

Deploying Lenovo certified configurations for Microsoft HCI solutions takes the guesswork out of system configuration. Whether you intend to build a converged or hyperconverged S2D cluster, you can rest assured that purchasing a certified configuration will provide a rock solid foundation with minimal obstacles along the way. These node configurations are certified by Lenovo and validated by Microsoft for out-of-the-box optimization. Using the Lenovo ThinkAgile MX Certified Node configurations presented in this document, you can get up and running without lengthy design and build time, knowing that the solution will work as intended.

This document briefly discusses the Microsoft HCI certification programs, and then presents the Lenovo certified configurations that have been validated for use in a Microsoft HCI solution under these programs. Details of each node configuration are specified, including all key components. Since there is some latitude for component customization in these configurations, the rules for customization are also described.

Microsoft HCI certification overview

To provide the best experience and support to HCI customers in production, Microsoft introduced the WSSD certification program, which includes Windows Server operating systems through Windows Server 2016. For Windows Server 2019 and beyond, Microsoft has rebranded their HCI certification program as Microsoft “Azure Stack HCI.”

Microsoft WSSD program

Under this program, partners can offer three types of solutions: Software-Defined Storage (SDS), HCI Standard, and HCI Premium offerings. All the solution components discussed in this document fulfill the requirements for HCI Premium certification, which is the most rigorous and demanding of the three certifications available in the program.

Perhaps the greatest value to be derived from the WSSD program from a customer perspective is to reduce the risks and unknowns associated with deploying an HCI solution using “off the shelf” components. To earn certification in the WSSD program, Lenovo has met or exceeded multiple criteria set by Microsoft for quality, accelerated time to value, out-of-the-box optimization, and expedited problem resolution.

The Microsoft WSSD program is an intense certification program which includes the following requirements for hardware components:

- Servers and components must have Windows Server 2016 logo certification
- Key components must have SDDC “Additional Qualifiers” certification (SDDC-AQ)
  - Servers
  - Network adapters
  - Storage adapters (SAS/SATA HBAs)
  - Storage devices (NVMe, SSD, and HDD)

For more information about the Microsoft WSSD program, visit the following URL:

https://docs.microsoft.com/en-us/windows-server/sddc

Microsoft Azure Stack HCI program

Beginning with Windows Server 2019, Microsoft has rebranded their HCI certification program as Azure Stack HCI. According to Microsoft, “Azure Stack HCI is a hyper-converged Windows Server 2019 cluster that uses validated hardware to run virtualized workloads on-premises, optionally connecting to Azure services for cloud-based backup, site-recovery and more. Azure Stack HCI solutions use Microsoft-validated hardware to ensure optimal performance and reliability, and include support for technologies such as NVMe drives, persistent memory, and remote-direct memory access (RDMA) networking.”

Many of the certification requirements from the WSSD program have been carried over into the Azure Stack HCI program, which begins with Windows Server 2019 logo certification. Each key hardware component must pass rigorous testing procedures and be certified as an Azure Stack HCI component before it can be included in an Azure Stack HCI solution.

In addition to the specific certification requirements that must be met by the individual hardware components, Microsoft requires end-to-end solution validation for each configuration to be certified. This involves running the fully configured HCI solution for many hours, while putting it through various usage and potential failure scenarios.

What is unique about Lenovo certified configurations for Microsoft HCI solutions is our rigorous evaluation process to select the best components from our existing Lenovo product portfolio. The main objective is to ensure our customers will have great confidence in our HCI solutions for a production environment.

For more information about the Microsoft Azure Stack HCI program, visit the following URL:

https://docs.microsoft.com/en-us/windows-server/azure-stack-hci

To learn why deploying a certified configuration for S2D is an optimal path to success for S2D deployment, read the two-part Microsoft blog post at the following URLs:

https://cloudblogs.microsoft.com/windowsserver/2018/02/20/the-technical-value-of-wssd-validated-hci-solutions-part-1

https://cloudblogs.microsoft.com/windowsserver/2018/02/21/the-technical-value-of-validated-hci-solutions-part-2

ThinkAgile MX Series solutions

As previously discussed, the Microsoft HCI certification programs allow OEM partners to deliver pre-engineered, validated HCI solutions. Whether your preference is for a Certified Node or an Appliance, Lenovo has designed, tested and validated the ThinkAgile MX Series offerings to quickly and easily provide the solutions you need, with the confidence required to exceed the stringent requirements of today’s IT. The result is that you can quickly deploy a robust, high-performance storage solution and rapidly solve your IT challenges.

ThinkAgile MX Certified Node

The Lenovo ThinkAgile MX Certified Node Series of solutions maps to Microsoft “Azure Stack HCI Validated Nodes.” These solutions package Microsoft-certified HCI solutions into easy-to-use machine types to provide the following:

- Easy to order
- Enforced configuration rules to ensure a valid configuration
- Best recipe firmware
- ThinkAgile Advantage (where available)
- Optional services such as deployment, management, etc.

ThinkAgile MX Appliance

Lenovo ThinkAgile MX Appliances map to Microsoft “Azure Stack HCI Integrated Systems.” These solutions are based on exactly the same hardware as ThinkAgile MX Certified Nodes. The only differences between a ThinkAgile MX Certified Node and Appliance that are based on the same server (for example, the ThinkSystem SR650 rack server) is that the Appliance configuration includes the following items:

- Azure Stack HCI operating system is preloaded before shipping to the customer
- ThinkAgile Advantage Support for 3 years (can be uplifted to a longer term, quicker response time, or both via Premier support)

The remainder of this document focuses on describing the existing Lenovo configurations that have been certified under the Microsoft HCI certification programs and the details of key components contained in each configuration. The purpose of this document is to provide guidance for Lenovo customers and technical pre-sales personnel during the process of configuring a Microsoft certified HCI solution for production usage. This document assumes the reader has prior knowledge of Microsoft HCI technologies, including S2D.

Lenovo certified configurations for Microsoft Azure Stack HCI

The Microsoft HCI certification programs allow for solution certification using a min/max paradigm. Under the program, OEM partners are allowed to certify a minimum configuration and a maximum configuration in order to receive certification of all configurations that lie between these extremes. Therefore, the configurations presented in this document represent examples of what has been certified, rather than an exhaustive list of the only certified configurations that are available. Refer to “Component selection” on page 23 for additional information regarding the components that have been certified. Also, refer to “Special considerations for ThinkAgile MX1020 and MX1021 on SE350” on page 21 for information related to the unique characteristics of this Edge Server when used as an Azure Stack HCI cluster node.

Table 1 lists the key components of the example configurations for S2D that have been certified under the Microsoft WSSD program for Windows Server 2016 and the Azure Stack HCI program for Windows Server 2019. Depending on the configuration, the number of nodes can range from a minimum of 2 to a maximum of 16. Note that we regularly certify additional configurations as time and resources allow.

The format of the configuration name follows a specific pattern. The first two or three alphabetic characters define the storage types included in the configuration (“N” for NVMe, “S” for SSD, and “H” for HDD). The next three or four alphanumeric characters define the total raw storage capacity of the node (e.g. “80T” indicates a total capacity of 80TB per node). The next numeric character defines the configuration sequence for the given component parameters. For example, if there are two certified configurations that contain NVMe and HDD storage devices with a total raw capacity of 80TB per node, they would be referred to as NH80T**1**a and NH80T**2**a. The final letter represents the revision of that particular configuration.

Table 1 Example configuration highlights for Lenovo ThinkAgile MX Certified Nodes[1]

Config	CPU/RAM	Cache	Capacity	SAS HBA	Network	Nodes
SH40T1a (hybrid)	ThinkAgile MX 2 CPUs 192GB-1.5TB	4 x 800GB SSD FC: B170	10 x 4TB FC: AUU8	430-16i FC: AUNM	Mellanox CX-4 2-port 25GbE FC: AUAJ[2]	2-16
SH60T1a (hybrid)	ThinkAgile MX 2 CPUs 192GB-1.5TB	4 x 1.6TB SSD FC: B171	10 x 6TB FC: AUUA	430-16i FC: AUNM	Mellanox CX-4 2-port 25GbE FC: AUAJ[2]	2-16
NH80T1a (hybrid)	ThinkAgile MX 2 CPUs 192GB-1.5TB	4 x 3.2TB NVMe (U.2) FC: B2XG	10 x 8TB FC: AUU9	430-16i FC: AUNM	Mellanox CX-4 2-port 25GbE FC: AUAJ[2]	2-16
NH120T1a (hybrid)	ThinkAgile MX 2 CPUs 192GB-1.5TB	4 x 3.2TB NVMe (U.2) FC: B2XG	10 x 12TB FC: B118	430-16i FC: AUNM	Mellanox CX-4 2-port 25GbE FC: AUAJ[2]	2-16
NS61T1a (all-flash)	ThinkAgile MX 2 CPUs 192GB-1.5TB	4 x 750GB Optane NVMe (U.2) FC: B2ZJ	16 x 3.84TB SSD FC: B49C	3 x 430-8i FC: AUNL	Mellanox CX-4 2-port 100GbE FC: ATRP[3]	4-16
NS77T1a (all-flash)	ThinkAgile MX 2 CPUs 192GB-1.5TB	4 x 3.2TB NVMe (U.2) FC: B11K	20 x 3.84TB SSD FC: B49C	3 x 430-8i FC: AUNL	Mellanox CX-4 2-port 100GbE FC: ATRP[3]	2-16
NN38T1a (all-flash)	ThinkAgile MX 2 CPUs 192GB-1.5TB	12 x 3.2TB NVMe (U.2) FC: B11K (all-NVMe)		3 x 430-8i FC: AUNL	Mellanox CX-4 2-port 100GbE FC: ATRP[3]	2-4
SS92T1a (all-flash)	ThinkAgile MX 2 CPUs 192GB-1.5TB	24 x 3.84TB SSD FC: B49C (all-SSD)		3 x 430-8i FC: AUNL	Mellanox CX-4 2-port 100GbE FC: ATRP[3]	2-16
NN16T1a	ThinkAgile MX1021 1 CPU 64-256GB	8 x 2TB NVMe FC: B75E (all-NVMe)		N/A	SE350 10GbE SFP+ 2-port Wired Network Module FC: B6F4[4]	2-4[5]
NN12T1a	ThinkAgile MX1021 1 CPU 64-256GB	2 x 650GB High Endurance NVMe FC: B75C	6 x 2TB NVMe FC: B75E	N/A	SE350 10GbE SFP+ 2-port Wired Network Module FC: B6F4[4]	2-4[5]
SS08T1a	ThinkAgile MX1021 1 CPU 64-256GB	4 x 1.92TB SATA SSD (non-SED) FC: B75B		Onboard SATA Controller	SE350 10GbE SFP+ 2-port Wired Network Module FC: B6F4[4]	2-4[5]

[1] This list is not exhaustive and can be customized. Refer to the “Component selection” on page 23 for information about customizing these configurations. All configurations use a dual 480GB M.2 SSD configured as a RAID-1 mirrored volume for OS boot.

[2] Mellanox CX-4 1-port 40GbE (FC ATRN) and Cavium/QLogic QL41262 2-Port 25GbE (FC B21R) are also certified for this configuration.

[3] Mellanox CX-4 2-port 25GbE (FC AUAJ) and Cavium/QLogic QL41262 2-Port 25GbE (FC B21R) are also certified for this configuration.

[4] SE350 10GBASE-T 4-port Wired Network Module (FC B7Z7) and SE350 Wireless Network Module (FC B6F3) are also certified for this configuration.

[5] Only 2 nodes are supported for direct-connect (switchless) configurations using the SE350.

Lenovo certified configuration details

This section includes details of each of the example Lenovo configurations contained in Table 1 that have been certified under the Microsoft HCI certification programs. Each

configuration lists the Lenovo ThinkAgile MX Certified Node or ThinkSystem™ rack server that is used for the S2D cluster node, as well as the storage and network devices that have been certified for the configuration.

Again, the configurations shown are example configurations and are not meant to provide an exhaustive list of all available certified configurations. Refer to “Component selection” on page 23 for additional information regarding components that have been certified. Also, refer to “Special considerations for ThinkAgile MX1020 and MX1021 on SE350” on page 21 for information related to the unique characteristics of this Edge Server when used as an Azure Stack HCI cluster node. If you have questions about the validity of a configuration you would like to purchase, check with your account team.

SH40T1a hybrid configuration

This configuration uses the Lenovo ThinkAgile MX Certified Node configured with SSDs for the cache tier and HDDs for the capacity tier. Total raw capacity of this configuration is 40TB per node.

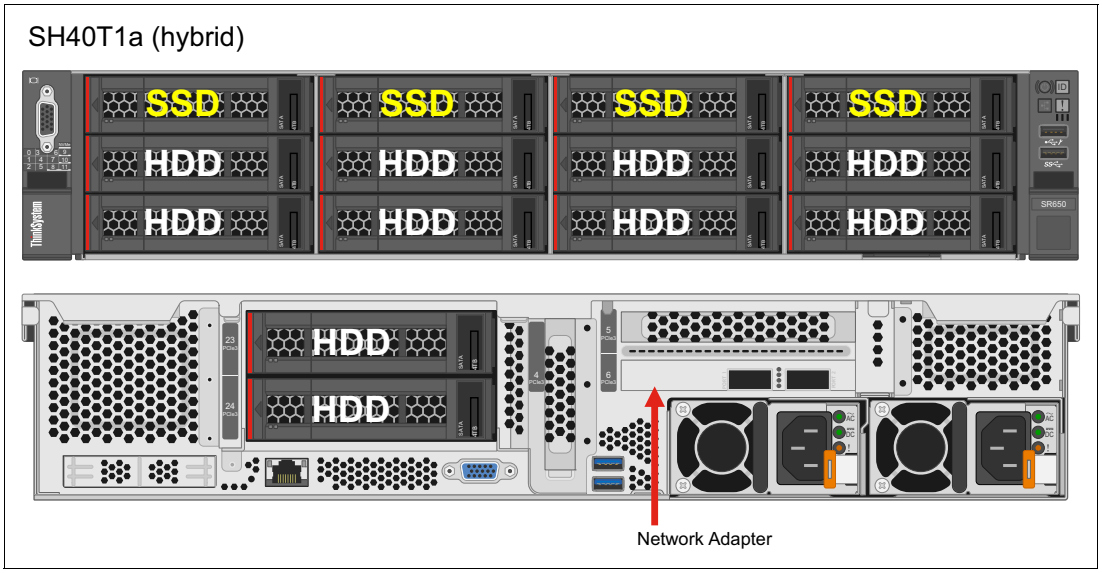

Figure 1 Lenovo ThinkAgile MX Certified Node configuration SH40T1a

Additional details include the following:

- Network adapter: The following network adapters have been certified:
  - Mellanox ConnectX-4 2-port 10/25GbE Ethernet Adapter (FC AUAJ)
  - 2 x Mellanox ConnectX-4 1-port 40GbE Ethernet Adapter (FC ATRN)
    - 2 x Mellanox QSA 100G to 25G Cable Adapter (FC B306) are required if network switches do not support 40GbE
  - Cavium/QLogic QL41262 PCIe 25Gb 2-Port SFP28 Ethernet Adapter (FC B21R)
- Storage: The following storage devices have been certified:
  - Dual 480GB M.2 adapter configured for RAID-1 for OS boot (FC B919)
  - 430-16i SAS HBA (RAID not supported, FC AUNM)
  - 4 x 800GB LFF High Performance SAS SSD for cache (FC B170)
  - 10 x 4TB LFF 6Gbps NL SATA HDD for capacity (FC AUU8)

This is a general purpose configuration that uses SSD and HDD storage devices. It is recommended when raw capacity requirements are less than 40TB per node. Network bandwidth of 10GbE is generally adequate for this configuration. This is one of the configurations that has been certified for use in a 2-node Microsoft HCI solution.

SH60T1a hybrid configuration

This configuration uses the Lenovo ThinkAgile MX Certified Node configured with SSDs for the cache tier and HDDs for the capacity tier. Total raw capacity of this configuration is 60TB per node.

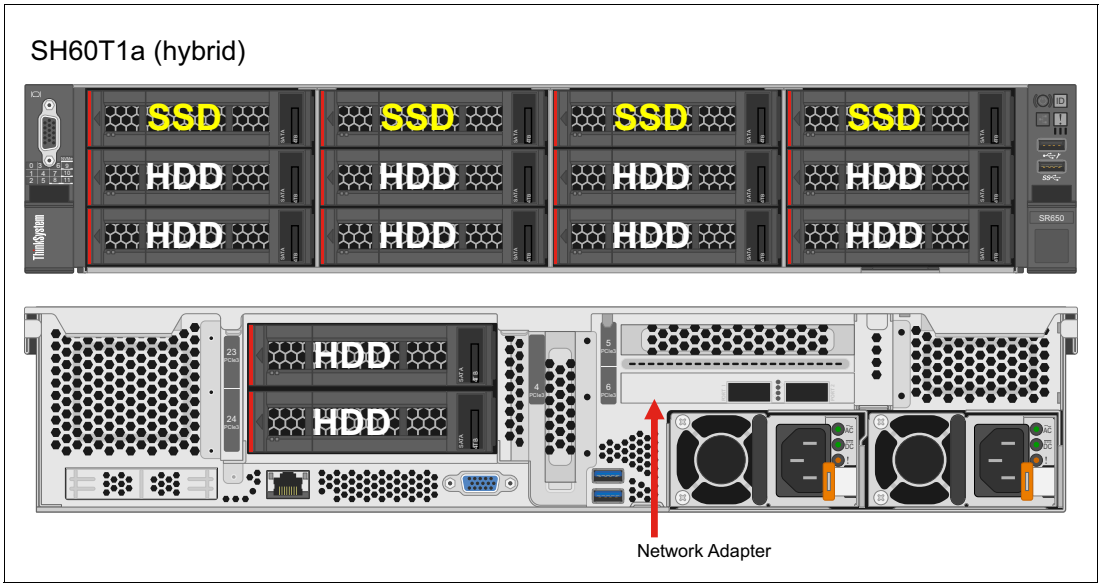

Figure 2 Lenovo ThinkAgile MX Certified Node configuration SH60T1a

Additional details include the following:

- CPU: 2 x Intel Gold or Platinum family processors
- Memory: 192GB - 1.5TB
- Network adapter: The following network adapters have been certified:
  - Mellanox ConnectX-4 2-port 10/25GbE Ethernet Adapter (FC AUAJ)
  - 2 x Mellanox ConnectX-4 1-port 40GbE Ethernet Adapter (FC ATRN)
    - 2 x Mellanox QSA 100G to 25G Cable Adapter (FC B306) are required if network switches do not support 40GbE
  - Cavium/QLogic QL41262 PCIe 25Gb 2-Port SFP28 Ethernet Adapter (FC B21R)
- Storage: The following storage devices have been certified:
  - Dual 480GB M.2 adapter configured for RAID-1 for OS boot (FC B919)
  - 430-16i SAS HBA (RAID not supported, FC AUNM)
  - 4 x 1.6TB LFF High Performance SAS SSD for cache (FC B171)
  - 10 x 6TB LFF 6Gbps NL SATA HDD for capacity (FC AUUA)

This is a general purpose configuration that uses SSD and HDD storage devices, with increased raw capacity of 60TB per node. It is recommended when a bit more storage capacity is required. A 16-node Microsoft HCI solution built using this configuration will provide a total raw storage capacity of nearly a petabyte.

NH80T1a hybrid configuration

This configuration uses the Lenovo ThinkAgile MX Certified Node configured with hot-swap NVMe U.2 devices for the cache tier and HDDs for the capacity tier. Total raw capacity of this configuration is 80TB per node.

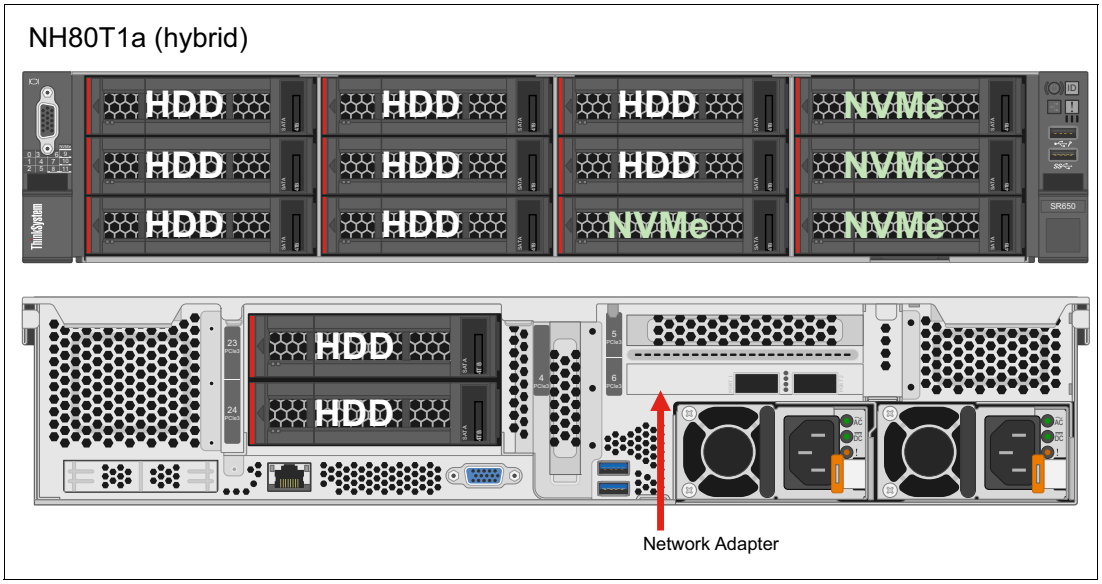

Figure 3 Lenovo ThinkAgile MX Certified Node configuration NH80T1a

Additional details include the following:

- CPU: 2 x Intel Gold or Platinum family processors
- Memory: 192GB - 1.5TB
- Network adapter: The following network adapters have been certified:
  - Mellanox ConnectX-4 2-port 10/25GbE Ethernet Adapter (FC AUAJ)
  - 2 x Mellanox ConnectX-4 1-port 40GbE Ethernet Adapter (FC ATRN)
    - 2 x Mellanox QSA 100G to 25G Cable Adapter (FC B306) are required if network switches do not support 40GbE
  - Cavium/QLogic QL41262 PCIe 25Gb 2-Port SFP28 Ethernet Adapter (FC B21R)
- Storage: The following storage devices have been certified:
  - Dual 480GB M.2 adapter configured for RAID-1 for OS boot (FC B919)
  - 430-16i SAS HBA (RAID not supported, FC AUNM)
  - 3 or 4 x 3.2TB LFF HS NVMe U.2 for cache (FC B2XG)
  - NVMe U.2 devices require AnyBay™ drive bays
  - 10 x 8TB LFF 6Gbps NL SATA HDD for capacity (FC AUU9)

Note: It is recommended to use a minimum of 25GbE network bandwidth for better HDD rebuild times for HDDs with a capacity of 8TB or more.

This is a high performance configuration that uses hot-swap NVMe U.2 devices inserted into the AnyBay drive bays as cache for the HDD capacity tier and has the same raw capacity of 80TB per node as Configuration NH80T1a. It is highly recommended to use a minimum network bandwidth of 25GbE in order to keep up with NVMe storage performance and also to potentially reduce HDD rebuild times. This is one of the configurations that has been certified for use in a 2-node Microsoft HCI solution.

NH120T1a hybrid configuration

This configuration uses the Lenovo ThinkAgile MX Certified Node configured with hot-swap NVMe U.2 devices for the cache tier and HDDs for the capacity tier. Total raw capacity of this configuration is 120TB per node.

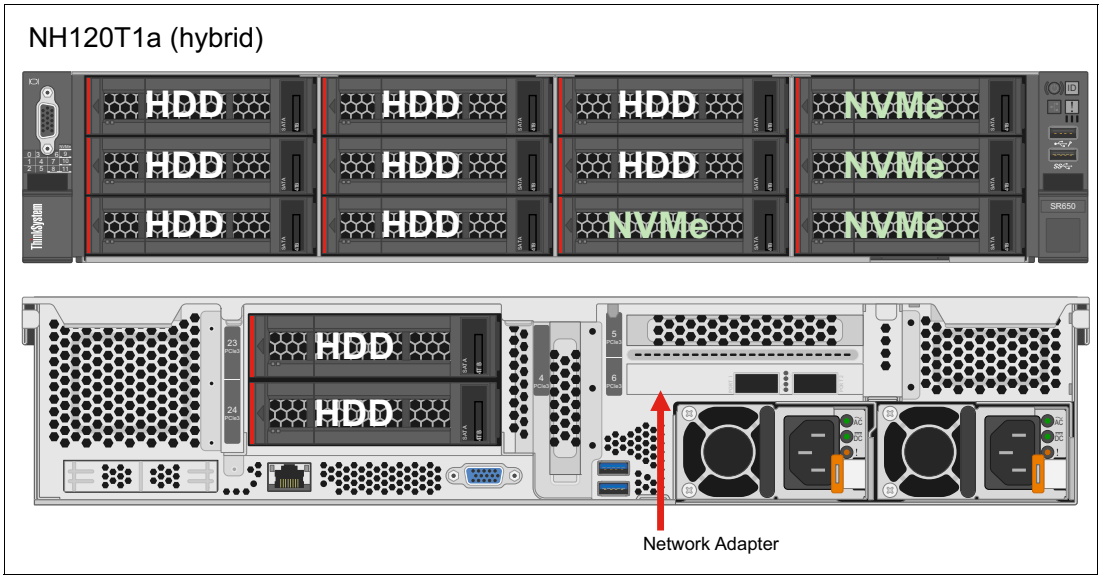

Figure 4 Lenovo ThinkAgile MX Certified Node configuration NH120T1a

Additional details include the following:

- CPU: 2 x Intel Gold or Platinum family processors
- Memory: 192GB - 1.5TB
- Network adapter: The following network adapters have been certified:
  - Mellanox ConnectX-4 2-port 10/25GbE Ethernet Adapter (FC AUAJ)
  - 2 x Mellanox ConnectX-4 1-port 40GbE Ethernet Adapter (FC ATRN)
    - 2 x Mellanox QSA 100G to 25G Cable Adapter (FC B306) are required if network switches do not support 40GbE
  - Cavium/QLogic QL41262 PCIe 25Gb 2-Port SFP28 Ethernet Adapter (FC B21R)
- Storage: The following storage devices have been certified:
  - Dual 480GB M.2 adapter configured for RAID-1 for OS boot (FC B919)
  - 430-16i SAS HBA (RAID not supported, FC AUNM)
  - 4 x 3.2TB LFF HS NVMe U.2 for cache (FC B2XG)
  - NVMe U.2 devices require AnyBay drive bays
  - 10 x 12TB LFF 6Gbps NL SATA HDD for capacity (FC B118)

Note: It is recommended to use a minimum of 25GbE network bandwidth for better HDD rebuild times for HDDs with a capacity of 8TB or more.

This is a high performance configuration that uses hot-swap NVMe U.2 devices inserted into the AnyBay drive bays as cache for the HDD capacity tier and has a total raw capacity of 120TB per node. It is highly recommended to use a minimum network bandwidth of 25GbE in order to keep up with NVMe storage performance and also to potentially reduce HDD rebuild times. A 16-node Microsoft HCI solution built using this configuration will provide a total raw storage capacity of nearly 2 Petabytes.

NS61T1a all-flash configuration

This configuration uses the Lenovo ThinkAgile MX Certified Node with 24 2.5” drive bays configured with U.2 NVMe devices for the cache tier and SSDs for the capacity tier. Total raw capacity of this configuration is approximately 61TB per node. The focus of this configuration is performance rather than large capacity.

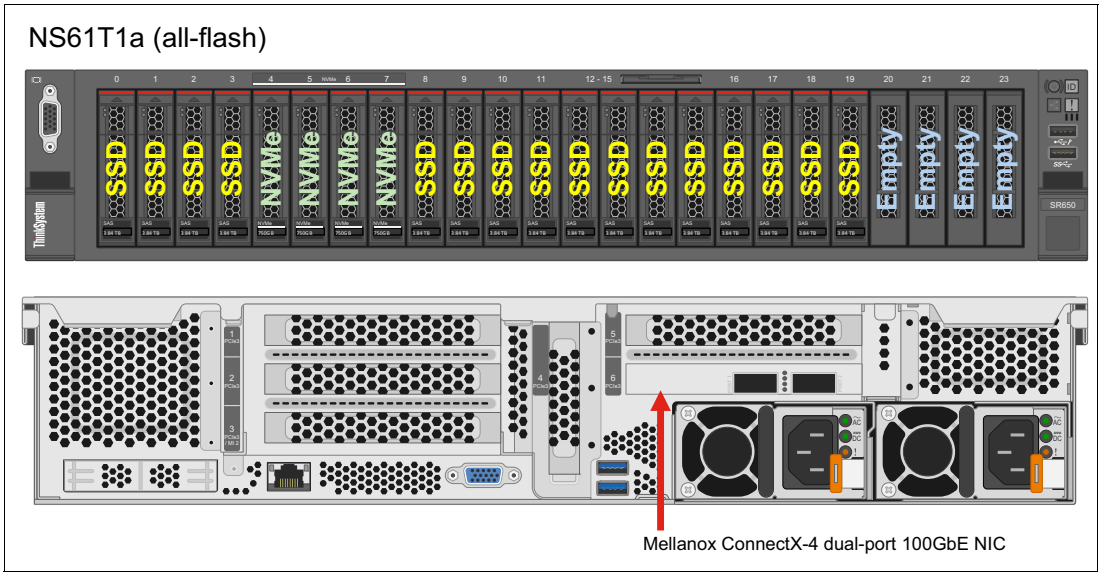

Figure 5 Lenovo ThinkAgile MX Certified Node configuration NS61T1a

Additional details include the following:

- CPU: 2 x Intel Gold or Platinum family processors
- Memory: 192GB - 1.5TB
- Network adapter: The following network adapters have been certified:
  - Mellanox ConnectX-4 2-port 100GbE Ethernet Adapter (FC ATRP)
  - 2 x Mellanox ConnectX-6 HDR100 QSFP56 1-port PCIe InfiniBand Adapter (FC B4R9)
  - Mellanox ConnectX-6 HDR100 QSFP56 2-port PCIe InfiniBand Adapter (FC B4RA)
- Storage: The following storage devices have been certified:
  - Dual 480GB M.2 adapter configured for RAID-1 for OS boot (FC B919)
  - 3 x 430-8i SAS HBA (RAID not supported, FC AUNL)
  - 4 x 750GB High Performance Optane U.2 NVMe for cache (FC B2ZJ)
  - 16 x 3.84TB 6Gbps SATA SSD for capacity (FC B49C)

This is an ultra-high performance all-flash configuration that uses NVMe devices as cache for the SSD capacity tier, but has a smaller raw capacity of approximately 61TB per node. In order to achieve maximum performance, this configuration includes a 2-port 100GbE Mellanox network adapter in each node. The Mellanox ConnectX-6 adapters shown above support Ethernet, including RoCEv2, and have been certified for Azure Stack HCI.

NS77T1a all-flash configuration

This configuration uses the Lenovo ThinkAgile MX Certified Node with 24 2.5” drive bays configured with U.2 NVMe devices for the cache tier and SSDs for the capacity tier. Total raw capacity of this configuration is approximately 77TB per node. The focus of this configuration is performance rather than large capacity.

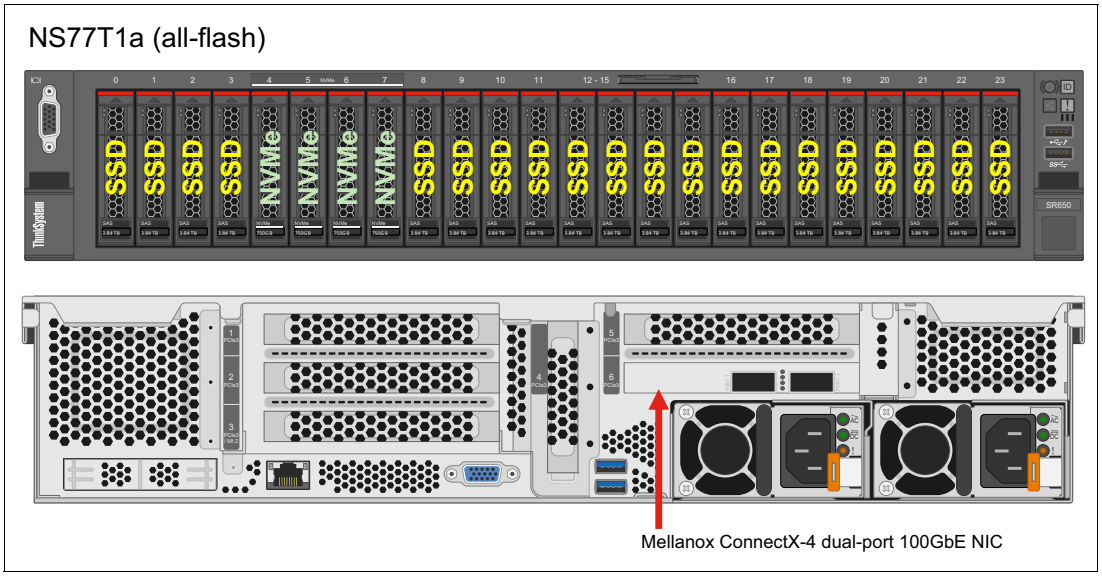

Figure 6 Lenovo ThinkAgile MX Certified Node configuration NS77T1a

Additional details include the following:

- CPU: 2 x Intel Gold or Platinum family processors
- Memory: 192GB - 1.5TB
- Network adapter: The following network adapters have been certified:
  - Mellanox ConnectX-4 2-port 100GbE Ethernet Adapter (FC ATRP)
  - 2 x Mellanox ConnectX-6 HDR100 QSFP56 1-port PCIe InfiniBand Adapter (FC B4R9)
  - Mellanox ConnectX-6 HDR100 QSFP56 2-port PCIe InfiniBand Adapter (FC B4RA)
- Storage: The following storage devices have been certified:
  - Dual 480GB M.2 adapter configured for RAID-1 for OS boot (FC B919)
  - 3 x 430-8i SAS HBA (RAID not supported, FC AUNL)
  - 4 x 3.2TB High Performance U.2 NVMe for cache (FC B11K)
  - 20 x 3.84TB 6Gbps SATA SSD for capacity (FC B0Z2)

This is an ultra-high performance all-flash configuration that uses NVMe devices as cache for the SSD capacity tier, but has a smaller raw capacity of approximately 77TB per node. In order to achieve maximum performance, this configuration includes a 2-port 100GbE Mellanox network adapter in each node. The Mellanox ConnectX-6 adapters shown above support Ethernet, including RoCEv2, and have been certified for Azure Stack HCI.

NN38T1a all-flash configuration (all-NVMe)

This configuration uses the Lenovo ThinkAgile MX Certified Node with 24 2.5” drive bays configured with U.2 NVMe devices as the only storage devices. Total raw capacity of this configuration is approximately 38TB per node. The focus of this configuration is performance rather than large capacity.

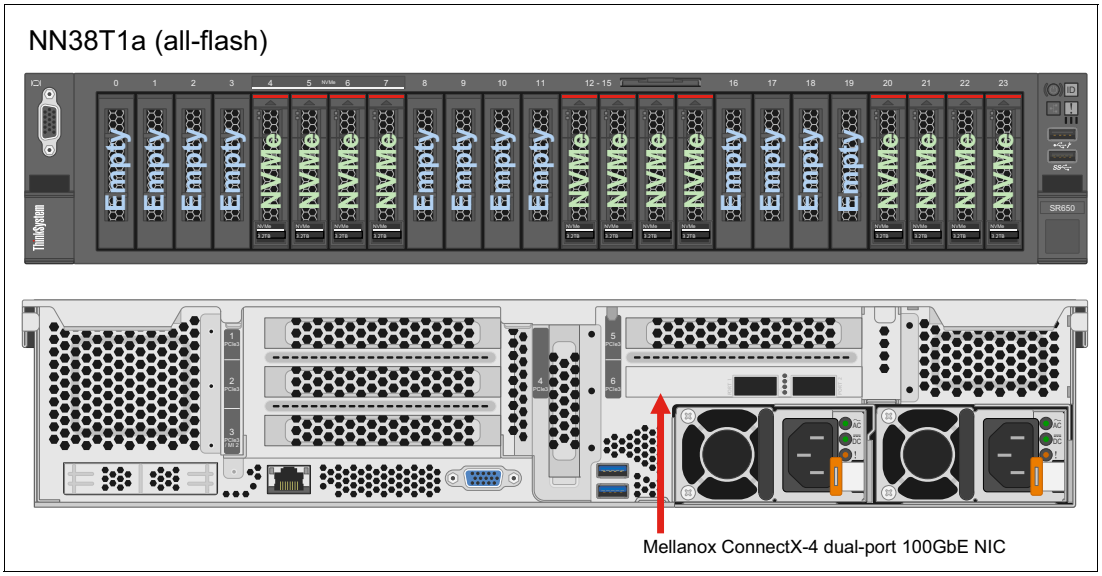

Figure 7 Lenovo ThinkAgile MX Certified Node configuration NN38T1a

Additional details include the following:

- CPU: 2 x Intel Gold or Platinum family processors
- Memory: 192GB - 1.5TB
- Network adapter: The following network adapters have been certified:
  - Mellanox ConnectX-4 2-port 100GbE Ethernet Adapter (FC ATRP)
  - 2 x Mellanox ConnectX-6 HDR100 QSFP56 1-port PCIe InfiniBand Adapter (FC B4R9)
  - Mellanox ConnectX-6 HDR100 QSFP56 2-port PCIe InfiniBand Adapter (FC B4RA)
- Storage: The following storage devices have been certified:
  - Dual 480GB M.2 adapter configured for RAID-1 for OS boot (FC B919)
  - 3 x 430-8i SAS HBA (RAID not supported, FC AUNL)
  - 2 x ThinkSystem 1610-4p NVMe Switch adapter (FC AUV2)
  - 12 x 3.2TB High Performance U.2 NVMe (FC B11K)

This is an ultra-high performance all-NVMe configuration that uses only NVMe devices for storage, but has a smaller raw capacity of approximately 38TB per node. In order to achieve maximum performance, this configuration includes a 2-port 100GbE Mellanox network adapter in each node. The Mellanox ConnectX-6 adapters shown above support Ethernet, including RoCEv2, and have been certified for Azure Stack HCI.

SS92T1a all-flash configuration (all-SSD)

This configuration uses the Lenovo ThinkAgile MX Certified Node with 24 2.5” drive bays configured with SSDs as the only storage devices. Total raw capacity of this configuration is approximately 92TB per node. The focus of this configuration is performance rather than large capacity.

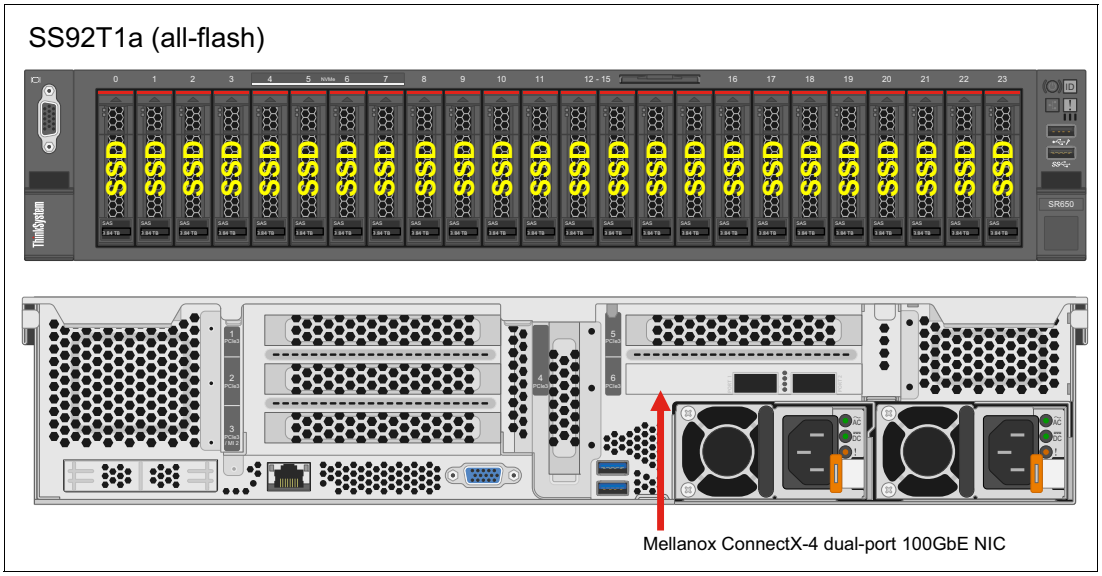

Figure 8 Lenovo ThinkAgile MX Certified Node configuration SS92T1a

Additional details include the following:

- CPU: 2 x Intel Gold or Platinum family processors
- Memory: 192GB - 1.5TB
- Network adapter: The following network adapters have been certified:
  - Mellanox ConnectX-4 2-port 100GbE Ethernet Adapter (FC ATRP)
  - 2 x Mellanox ConnectX-6 HDR100 QSFP56 1-port PCIe InfiniBand Adapter (FC B4R9)
  - Mellanox ConnectX-6 HDR100 QSFP56 2-port PCIe InfiniBand Adapter (FC B4RA)
- Storage: The following storage devices have been certified:
  - Dual 480GB M.2 adapter configured for RAID-1 for OS boot (FC B919)
  - 3 x 430-8i SAS HBA (RAID not supported, FC AUNL)
  - 24 x 3.84TB 6Gbps SATA SSD for capacity (FC B0Z2)

This is an ultra-high performance all-SSD configuration that uses only SSD devices for storage, but has a smaller raw capacity of approximately 92TB per node. In order to achieve maximum performance, this configuration includes a 2-port 100GbE Mellanox network adapter in each node. The Mellanox ConnectX-6 adapters shown above support Ethernet, including RoCEv2, and have been certified for Azure Stack HCI.

NN16T1a all-flash configuration (all-NVMe)

This configuration uses the Lenovo ThinkAgile MX1021 on SE350 Certified Node with eight 2TB NVMe storage devices configured as a single-tier solution. Total raw capacity of this configuration is approximately 16TB per node. The focus of this configuration is for Remote Office/Branch Office (ROBO) environments at the edge. It is typically deployed as a two-node direct-connected Azure Stack HCI solution.

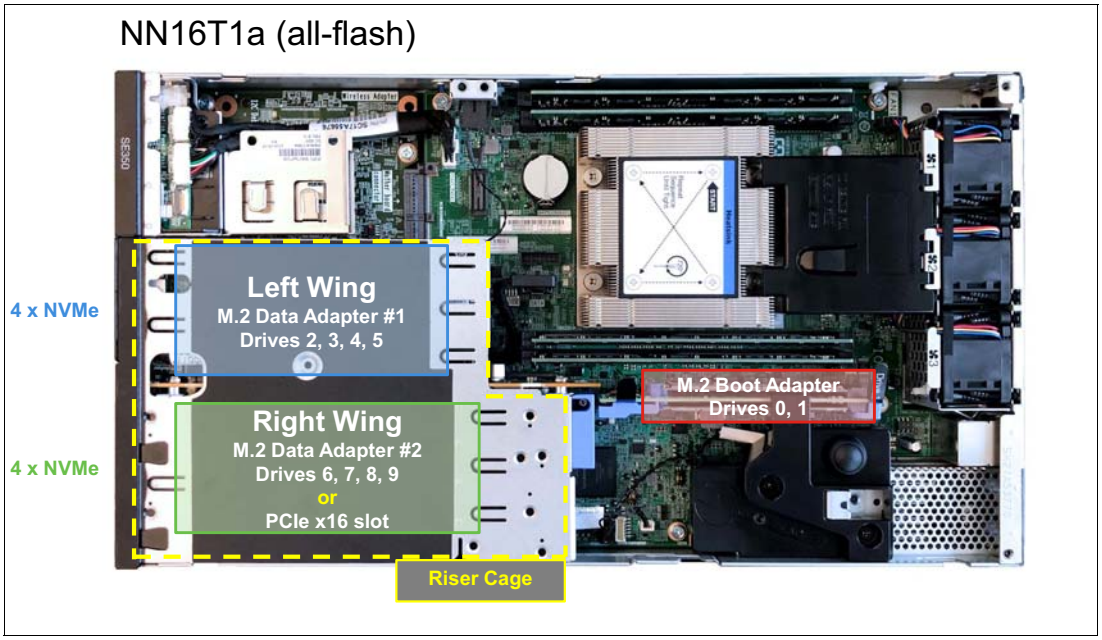

Figure 9 Lenovo ThinkAgile MX1021 on SE350 Certified Node configuration NN16T1a

Additional details include the following:

- CPU: 1 x Intel Xeon D-2100 series processor, soldered to system board
- Memory: 64GB - 256GB
- Network adapters: The following network modules have been certified:
  - SE350 10GbE SFP+ 2-port Wired Network Module (FC B6F4)
  - SE350 10GBASE-T 4-port Wired Network Module (FC B7Z7)
  - SE350 Wireless Network Module (FC B6F3)
- Storage: The following storage devices have been certified:
  - ThinkSystem SE350 M.2 Mirroring Enablement Kit for boot drives (FC B88P)
  - ThinkSystem M.2 480GB Industrial A600i SATA SSD for boot (FC B91K)
  - 2 x ThinkSystem SE350 M.2 SATA/NVMe 4-bay Data Drive Enablement Kit (FC B6FF)
  - 8 x 2TB ThinkSystem M.2 P4511 NVMe SED SSD (FC B75E)

This is a single-tier high performance all-NVMe configuration that uses only NVMe devices for storage, with a raw capacity of approximately 16TB per node. Based on the small form factor of the ThinkSystem SE350 Edge Server, this configuration is ideal for use at the edge, where high-speed network switches are not available to handle storage traffic inside the cluster. Note that for direct-connected scenarios, ThinkAgile MX1021 supports only 2 nodes due to the limited number of high-speed network ports available in these systems.

NN12T1a all-flash configuration (all-NVMe)

This configuration uses the Lenovo ThinkAgile MX1021 on SE350 Certified Node with two 650GB High Endurance NVMe storage devices configured as the Cache tier and six 2TB NVMe storage devices configured as the Capacity tier. Total raw capacity of this configuration is approximately 12TB per node. The focus of this configuration is for Remote Office/Branch Office (ROBO) environments at the edge. It is typically deployed as a two-node direct-connected Azure Stack HCI solution.

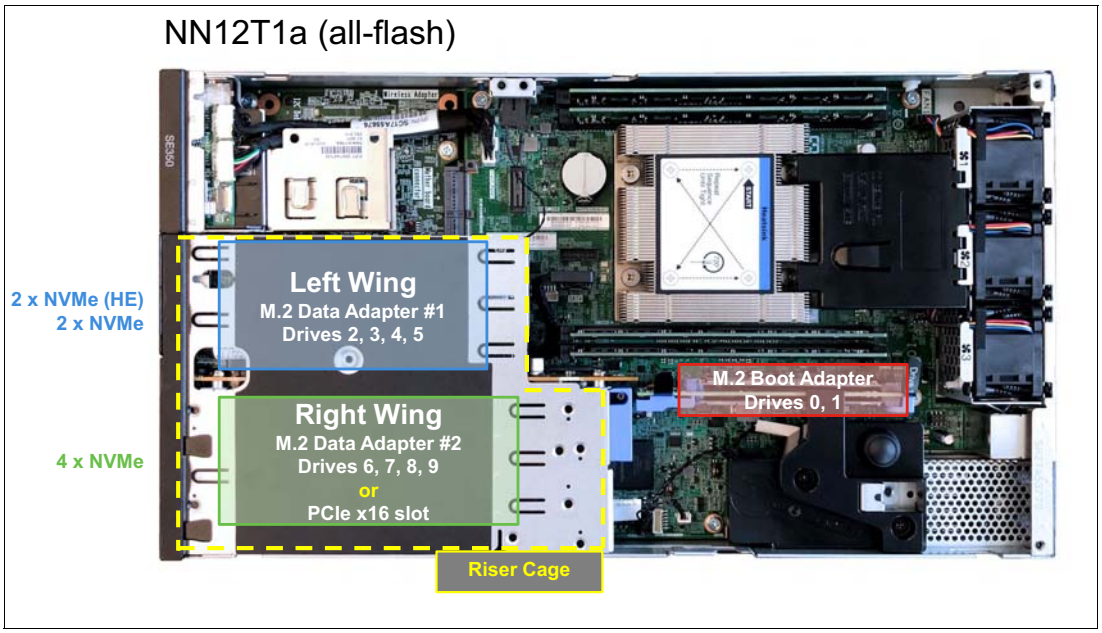

Figure 10 Lenovo ThinkAgile MX1021 on SE350 Certified Node configuration NN12T1a

Additional details include the following:

- CPU: 1 x Intel Xeon D-2100 series processor, soldered to system board
- Memory: 64GB - 256GB
- Network adapters: The following network modules have been certified:
  - SE350 10GbE SFP+ 2-port Wired Network Module (FC B6F4)
  - SE350 10GBASE-T 4-port Wired Network Module (FC B7Z7)
  - SE350 Wireless Network Module (FC B6F3)
- Storage: The following storage devices have been certified:
  - ThinkSystem SE350 M.2 Mirroring Enablement Kit for boot drives (FC B88P)
  - ThinkSystem M.2 480GB Industrial A600i SATA SSD for boot (FC B91K)
  - 2 x ThinkSystem SE350 M.2 SATA/NVMe 4-bay Data Drive Enablement Kit (FC B6FF)
  - 2 x 650GB ThinkSystem M.2 P4511 NVMe SED High Endurance SSD (FC B75C)
  - 6 x 2TB ThinkSystem M.2 P4511 NVMe SED SSD (FC B75E)

This is a two-tier high performance all-NVMe configuration that uses only NVMe devices for storage, with a raw capacity of approximately 12TB per node. Based on the small form factor of the ThinkSystem SE350 Edge Server, this configuration is ideal for use at the edge, where high-speed network switches are not available to handle storage traffic inside the cluster. Note that for direct-connected scenarios, ThinkAgile MX1021 supports only 2 nodes due to the limited number of high-speed network ports available in these systems.

SS08T1a all-flash configuration (all-SATA SSD)

This configuration uses the Lenovo ThinkAgile MX1021 on SE350 Certified Node with 4 1.92TB SATA SSD storage devices configured as a single-tier solution. Total raw capacity of this configuration is approximately 8TB per node. The focus of this configuration is for Remote Office/Branch Office (ROBO) environments at the edge. It is typically deployed as a two-node direct-connected Azure Stack HCI solution.

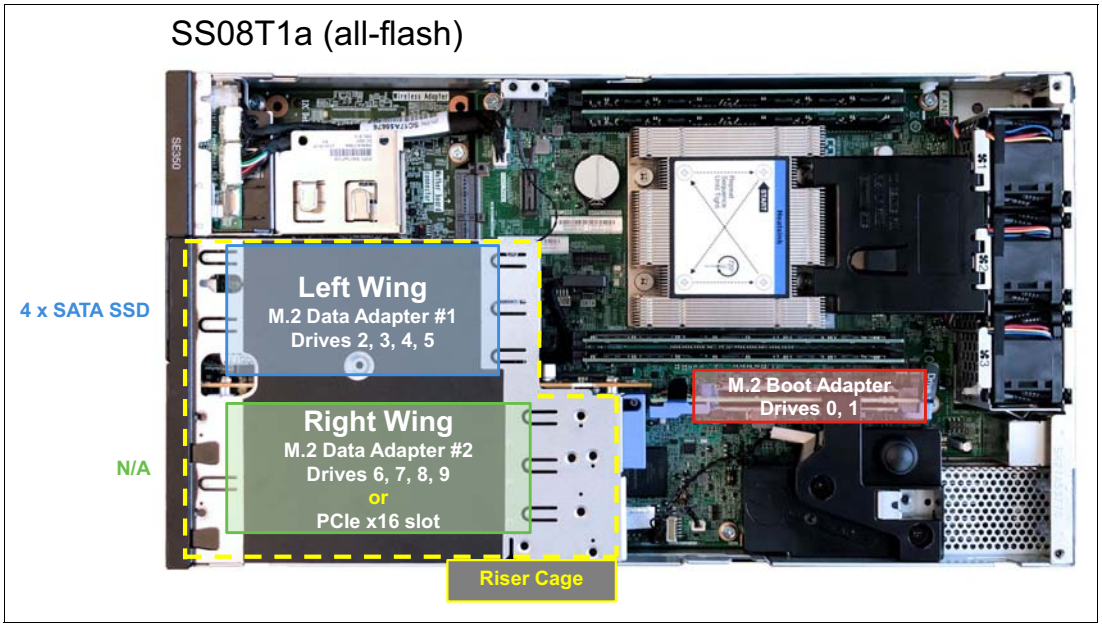

Figure 11 Lenovo ThinkAgile MX1021 on SE350 Certified Node configuration SS08T1a

Additional details include the following:

- CPU: 1 x Intel Xeon D-2100 series processor, soldered to system board
- Memory: 64GB - 256GB
- Network adapters: The following network modules have been certified:
  - SE350 10GbE SFP+ 2-port Wired Network Module (FC B6F4)
  - SE350 10GBASE-T 4-port Wired Network Module (FC B7Z7)
  - SE350 Wireless Network Module (FC B6F3)
- Storage: The following storage devices have been certified:
  - ThinkSystem SE350 M.2 Mirroring Enablement Kit for boot drives (FC B88P)
  - ThinkSystem M.2 480GB Industrial A600i SATA SSD for boot (FC B91K)
  - 1 x ThinkSystem SE350 M.2 SATA/NVMe 4-bay Data Drive Enablement Kit (FC B6FF)
  - 4 x 1.92TB ThinkSystem M.2 5100 Pro SATA 6Gbps SSD(FC B75B)

This is a single-tier all-SSD configuration that uses only non-SED SATA SSD devices for storage, but has a relatively small raw capacity of under 8TB per node. Based on the small form factor of the ThinkSystem SE350 Edge Server, this configuration is ideal for use at the edge, where high-speed network switches are not available to handle storage traffic inside the cluster. Note that for direct-connected scenarios, ThinkAgile MX1021 supports only 2 nodes due to the limited number of high-speed network ports available in these systems. Since SED storage devices cannot be shipped into certain countries, including China, the single-tier all-SSD configuration is currently the only ThinkAgile MX1021 configuration available in these countries.

Small cluster configurations

There are a few special factors that might come into play when considering a 2- or 3-node HCI configuration. This section outlines the details that are specific to these small HCI clusters. For special

Direct-connect networking

For a 2- or 3-node HCI cluster, it is possible to connect the network adapters directly to each other without placing a network switch between the nodes. For a 2-node cluster using the 2-port Mellanox ConnectX-4 10/25GbE network adapter as an example, this means that Port 1 of the adapter on one node can be cabled directly into Port 1 of the second node and Port 2 from each node can be direct-connected as well. In this example, the network cables are standard SFP28 Direct Attach Cables (DACs). There is no need for a “crossover” cable.

One of the most significant benefits associated with the direct-connect method is that high-speed network switches are not required for storage traffic inside the cluster (aka “east-west” traffic). However, since the network adapters are connected to each other, a separate network connection is required from the customer network to the cluster (aka “north-south” traffic). A low-cost option for this additional network interface is to use one of the LAN On Motherboard (LOM) cards available for the ThinkAgile MX Certified Node.

For most 2-node implementations, the 2-port 1GbE RJ45 LOM card option is sufficient. Table 2 shows the LOM card options that are available. Figure 12 shows how the high-speed network adapter and LOM card are used in a 2-node direct-connected solution.

Table 2 LOM card options

Number of Ports	Form Factor	Speed	Feature Code
2	RJ45	1GbE	AUKG
2	Base-T	10GbE	AUKL
2	SFP+	10GbE	AUKJ
4	RJ45	1GbE	AUKH
4	Base-T	10GbE	AUKM
4	SFP+	10GbE	AUKK

Important: The LOM cards shown in the table above are NOT certified to carry RDMA storage traffic inside the solution. These cards are offered only to connect the cluster to the customer network.

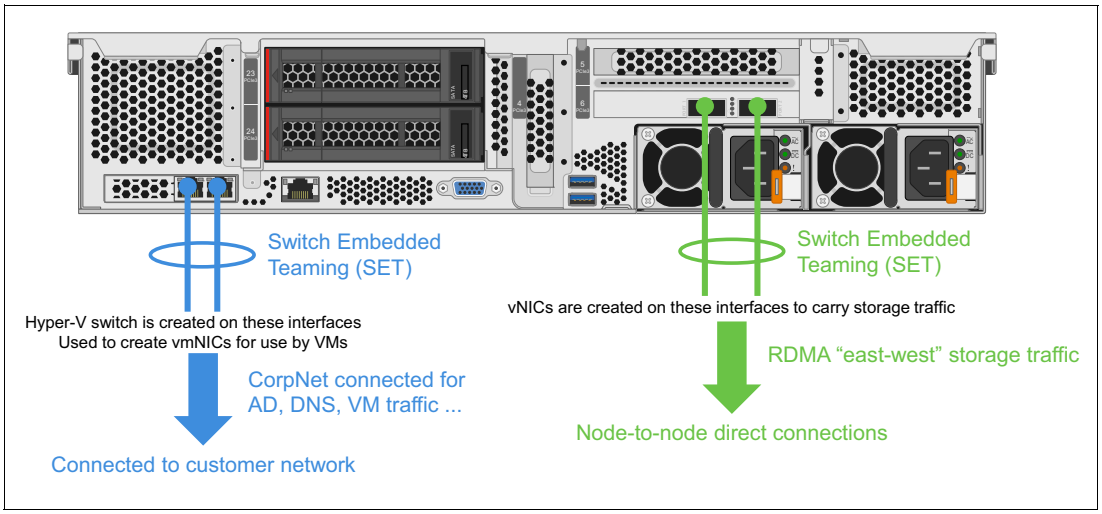

Figure 12 Diagram showing network connectivity for a ThinkAgile MX Certified Node that is part of a 2-node direct-connected HCI cluster.

USB file share witness

A new feature for Microsoft 2-node HCI clusters in Windows Server 2019 is the ability to use a “USB witness.” This capability allows the requirement for a cluster witness to be satisfied by a file share configured on a USB thumb drive inserted into a network router. This reduces the complexity of cluster setup in small environments, such as branch office locations. Figure 13 illustrates the USB witness capability for a direct-connected 2-node HCI cluster.

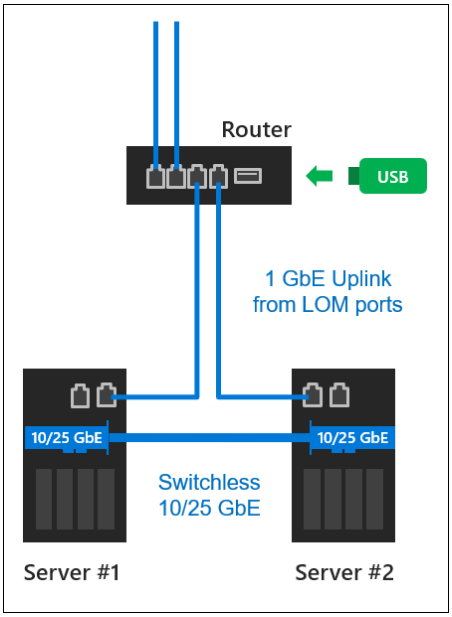

Figure 13 Illustration of USB file share witness for a direct-connected 2-node HCI cluster.

Special considerations for ThinkAgile MX1020 and MX1021 on SE350

The ThinkSystem SE350 Edge Server is a purpose-built server that is half the width and significantly shorter than a traditional server, making it ideal for deployment in tight spaces. It can be mounted on a wall, stacked on a shelf or mounted in a rack. The ThinkSystem SE350 puts increased processing power, storage and network closer to where data is generated, allowing actions resulting from the analysis of that data to take place more quickly. This makes it ideal for edge computing, including Azure Stack HCI workloads in retail, video

security, inventory management, building control, telecommunications, manufacturing, and other environments where a small system form factor is required.

Due to the unique design of the ThinkSystem SE350 Edge Server, there are several special guidelines that apply to ThinkAgile MX1020 and MX1021 on SE350. This section provides these guidelines and some recommendations for configuring a ThinkAgile MX1020 and MX1021 solutions.

Although the SE350 Edge Server has been certified for use in Azure Stack HCI clusters containing from two to four nodes, its intended purpose is at the edge in a two-node direct-connected cluster. Due to the limited number of 10GbE network ports provided by the SE350 Network Modules, it is not practical to build a cluster containing more than two nodes without requiring a high-speed network switch to handle the storage traffic.

Since there are no hard disk drives available for the SE350, all-flash configurations are the only configurations available for ThinkAgile MX1020 and MX1021 (i.e. hybrid configurations are not available). Furthermore, the all-flash configurations that are available are actually all-NVMe or all-SSD configurations. Lenovo has not certified a mix of NVMe and SATA SSD data devices for use as an Azure Stack HCI cluster node. Three example configurations can be found in this document, including NN16T1a (single-tier all-NVMe), NN12T1a (two-tier all-NVMe), and SS08T1a (single-tier all-SSD).

In addition to the storage device caveats discussed in the previous paragraph, note that SED storage devices cannot be shipped into certain countries, including China. The only non-SED data storage devices that are currently available for the SE350 are SATA SSD devices. Also, since the SE350 supports a maximum of four SATA SSDs, which is the minimum number of devices required for an Azure Stack HCI cluster node, storage configuration for these solutions is essentially limited to the size (480GB, 960GB, or 1.92TB) of the four SATA SSDs selected. This represents an approximate total raw storage capacity per node of 2TB, 4TB, and 8TB, respectively.

For the OS Boot device, ThinkAgile MX1020 and MX1021 are identical to other ThinkAgile MX solutions, using dual 480GB M.2 SSD devices configured as a RAID-1 mirrored Boot volume using the ThinkSystem SE350 M.2 Mirroring Enablement Kit.

The SE350 is a single-processor server, using a single Intel Xeon D-2100 series processor. In addition, since there are only 4 DIMM sockets available, memory capacity is restricted to a range between 64 and 256GB per node.

ThinkAgile MX1020 and MX1021 support only the iWARP implementation of RDMA via its integrated Network Modules. Lenovo does not currently support the addition of *any* PCIe network adapters to ThinkAgile MX1020 or MX1021 solutions. If you are interested in adding such a network adapter to nodes, please contact your sales representative to engage the Lenovo Special Bid process.

For information related to deploying a two-node direct-connected Azure Stack HCI cluster using ThinkAgile MX1021 on SE350, refer to the Lenovo Press document *ThinkAgile MX1021 on SE350 Azure Stack HCI (S2D) Deployment Guide*, which can be downloaded from the following URL:

https://lenovopress.com/lp1298

Component selection

The Lenovo certified configurations listed above include several common hardware components. Depending on workloads and other requirements, there is some flexibility in customization of each configuration to meet a large range of customer needs. However, the following configuration guidelines *must* be followed:

- Node
  - Besides Lenovo ThinkAgile MX Certified Nodes, only the Lenovo ThinkSystem SR630 are certified for Azure Stack HCI.
  - The Lenovo ThinkSystem SR630 is not available as a ThinkAgile MX Certified Node at the time, but can be configured appropriately for use as a Microsoft Azure Stack HCI cluster node.
  - In general, the number of nodes can range from 2 to 16 (refer to Table 1 on page 8), but not all configurations have been certified for this full range.
  - The Lenovo ThinkSystem SR630 can be ordered in the configurations listed in Table 1 on page 8, with the exception of storage devices. Since the SR630 is a 1U rack server that supports up to 12 x 2.5” or 4 x 3.5” storage devices, these limitations must be kept in mind when configuring an SR630-based solution.
- Processor
  - Two Intel processors with a recommended minimum of 8 cores per CPU in the Silver (4100 series) Gold (5100 or 6100 series) or Platinum (8100 series) processor families
  - Single Intel Xeon D-2100 processor is supported for ThinkAgile MX1021 on SE350
  - 205 watt processors are not supported
- Memory
  - Minimum of 192GB is required for converged, 384GB for hyperconverged
  - For ThinkAgile MX1021 on SE350, minimum of 64GB for converged, 128GB for hyperconverged
  - Maximum of 1.5TB per node
  - We strongly recommend a “balanced memory configuration” - for details, see the following URL: http://lenovopress.com/lp0742.pdf
- OS Boot (not part of Microsoft Azure Stack HCI certification)
  - Minimum requirement is 200GB OS boot volume
  - M.2 Mirroring Kit with dual 480GB M.2 SSD configured as RAID-1 for resilience are specified in all Lenovo ThinkAgile MX Certified Node configurations
    - For nodes using SR630 and SR650 rack servers, the ThinkSystem M.2 5300 480GB SATA 6Gbps Non-Hot Swap SSD (Feature Code B919) is used
    - For nodes using SE350 Edge servers, ThinkSystem M.2 480GB Industrial A600i SATA SSD (Feature Code B91K) is used
  - If hot swap storage is preferred for boot, we recommend a RAID card configured for RAID-1 with two SSDs or two HDDs
- GPU
  - Certain GPU adapters have been certified for use with ThinkAgile MX solutions
  - Refer to “GPU adapter support” on page 28 for specific information regarding supported GPUs
- Networking
  - We recommend 25GbE for 8TB or above HDD for improved HDD rebuild time
  - For RoCE v2:
    - Mellanox ConnectX-4 Lx 2-port 10/25GbE Ethernet Adapter (use this NIC for typical hybrid storage configurations)

- Mellanox ConnectX-4 Lx 2-port 100GbE Ethernet Adapter (use this NIC for all-flash storage configurations when the additional throughput is required)
- Mellanox ConnectX-6 HDR100 QSFP56 2-port PCIe InfiniBand Adapter (this NIC also supports Ethernet, including RoCE v2, and can be used for all-flash storage configurations when additional throughput is required)
- Mellanox ConnectX-6 HDR100 QSFP56 1-port PCIe InfiniBand Adapter (this NIC also supports Ethernet, including RoCE v2, and can be used for all-flash storage configurations when additional throughput is required and two 1-port NICs are preferred over a single 2-port NIC)
- Mellanox ConnectX-4 Lx 1-port 40GbE Ethernet Adapter with Mellanox QSA 100G to 25G Cable Adapter (use this NIC/Cable Adapter combination if two 1-port NICs are preferred over a single 2-port NIC)
- SFP+ DAC cables support 10Gb and SFP28 DAC cables support 25Gb port speed
- Network switches must support the RoCE v2 feature set for best storage performance (see “Network switches” on page 28 for more information regarding Lenovo and NVIDIA/Mellanox network switches that have been tested with ThinkAgile MX solutions)

– For iWARP:
- ThinkSystem SE350 supports iWARP via its integrated Network Modules
- Cavium/QLogic QL41262 PCIe 25Gb 2-Port SFP28 Ethernet Adapter
- For more information about the Cavium/QLogic network adapter, see the Product Guide at the following URL:

  https://lenovopress.com/lp0839-thinksystem-qlogic-ql41262-25gb-ethernet-adapter

Notes: Although the Cavium/QLogic QL41262 NIC can be configured for RoCE v2 or iWARP, this NIC has been certified only for iWARP. If you prefer to use RoCE v2, use one of the Mellanox NICs listed.

For ThinkSystem SR650 and SR630 servers, LOM ports are supported for north-south traffic in direct-connected clusters, but not for east-west (storage) traffic, as discussed in “Direct-connect networking” on page 20.

► Storage HBA

– ThinkSystem 430-16i SAS/SATA 12Gb HBA
  - Used for hybrid storage configurations

– ThinkSystem 430-8i SAS/SATA 12Gb HBA
  - Used for all-flash configurations

– ThinkSystem SE350 M.2 SATA/NVMe 4-bay Data Drive Enablement Kit
  - Used only for ThinkAgile MX1021 on SE350

► NVMe switch adapter

– ThinkSystem 1610-4p NVMe Switch adapter
  - NVMe switches are used for configurations that include more than 4 NVMe devices

► Storage devices

– For configurations with two storage device types, the number of devices can be reduced to a minimum of two cache and four capacity devices
– For configurations with a single storage device type (all-SSD or all-NVMe), the number of devices can be reduced to a total of 4 SSD or 4 NVMe devices
– NVMe U.2 devices require AnyBay option

We strongly recommend a minimum 10% cached to capacity ratio (e.g. 2x 800GB SSD and 4x 4TB HDD). Although this is not a requirement, care should be taken to provide enough cache space for the amount of capacity available in the solution or performance can be impacted significantly.

Table 3 provides a list of all certified Lenovo storage devices that can be used to configure a Hybrid Storage HCI solution based on the Lenovo ThinkAgile MX Certified Node. This table does not include OS boot devices, which are covered in “Component selection” on page 23.

Table 3 Lenovo storage devices certified for Microsoft S2D in ThinkAgile MX hybrid storage solutions

Storage Devices Used for Hybrid Storage Solutions	Feature Code	Type	Usage
ThinkSystem 3.5" Intel P4610 1.6TB Mainstream NVMe PCIe 3.0 x4 Hot Swap SSD	B58C	NVMe	Cache
ThinkSystem 3.5" Intel P4610 3.2TB Mainstream NVMe PCIe 3.0 x4 Hot Swap SSD	B58D	NVMe	Cache
ThinkSystem 3.5" Intel P4610 6.4TB Mainstream NVMe PCIe 3.0 x4 Hot Swap SSD	B58E	NVMe	Cache
ThinkSystem 3.5" Intel S4610 480GB Mainstream SATA 6Gb Hot Swap SSD	B49S	SSD	Cache
ThinkSystem 3.5" Intel S4610 960GB Mainstream SATA 6Gb Hot Swap SSD	B49T	SSD	Cache
ThinkSystem 3.5" Intel S4610 1.92TB Mainstream SATA 6Gb Hot Swap SSD	B49U	SSD	Cache
ThinkSystem 3.5" Intel S4610 3.84TB Mainstream SATA 6Gb Hot Swap SSD	B49V	SSD	Cache
ThinkSystem 3.5” SS530 800GB Performance SAS 12Gb Hot Swap SSD	B4Y8	SSD	Cache
ThinkSystem 3.5” SS530 1.6TB Performance SAS 12Gb Hot Swap SSD	B4Y9	SSD	Cache
ThinkSystem 3.5” SS530 3.2TB Performance SAS 12Gb Hot Swap SSD	B4YA	SSD	Cache
ThinkSystem 3.5" PM1645a 800GB Mainstream SAS 12Gb Hot Swap SSD	B8HT	SSD	Cache
ThinkSystem 3.5" PM1645a 1.6TB Mainstream SAS 12Gb Hot Swap SSD	B8JN	SSD	Cache
ThinkSystem 3.5" PM1645a 3.2TB Mainstream SAS 12Gb Hot Swap SSD	B8JK	SSD	Cache
ThinkSystem 3.5" 4TB 7.2K SATA 6Gb Hot Swap 512n HDD	AUU8	HDD	Capacity
ThinkSystem 3.5" 6TB 7.2K SATA 6Gb Hot Swap 512e HDD	AUUA	HDD	Capacity
ThinkSystem 3.5" 8TB 7.2K SATA 6Gb Hot Swap 512e HDD	AUU9	HDD	Capacity
ThinkSystem 3.5" 10TB 7.2K SATA 6Gb Hot Swap 512e HDD	AUUB	HDD	Capacity
ThinkSystem 3.5" 12TB 7.2K SATA 6Gb Hot Swap 512e HDD	B118	HDD	Capacity
ThinkSystem 3.5" 4TB 7.2K NL SAS 12Gb Hot Swap 512n HDD	AUU6	HDD	Capacity
ThinkSystem 3.5" 6TB 7.2K NL SAS 12Gb Hot Swap 512n HDD	AUU7	HDD	Capacity
ThinkSystem 3.5" 8TB 7.2K NL SAS 12Gb Hot Swap 512n HDD	B0YR	HDD	Capacity
ThinkSystem 3.5" 10TB 7.2K NL SAS 12Gb Hot Swap 512n HDD	AUUG	HDD	Capacity
ThinkSystem 3.5" 12TB 7.2K NL SAS 12Gb Hot Swap 512n HDD	B117	HDD	Capacity
ThinkSystem 3.5" 14TB 7.2K NL SAS 12Gb Hot Swap 512n HDD	B496	HDD	Capacity

Table 4 provides a list of all certified Lenovo storage devices that can be used to configure an All-Flash HCI solution based on the Lenovo ThinkAgile MX Certified Node. This table does not include OS boot devices, which are covered in “Component selection” on page 23.

Table 4 Lenovo storage devices certified for Microsoft S2D in ThinkAgile MX all-flash storage solutions

Storage Devices Used for All-Flash Solutions	Feature Code	Type	Usage
ThinkSystem U.2 Intel P4800X 750GB Performance NVMe PCIe 3.0 x4 HS SSD	B2ZJ	NVMe	Cache

Storage Devices Used for All-Flash Solutions	Feature Code	Type	Usage
ThinkSystem U.2 Intel P5600 1.6TB Mainstream NVMe PCIe 3.0 x4 HS SSD	B589	NVMe	Cache
ThinkSystem U.2 Intel P5600 3.2TB Mainstream NVMe PCIe 3.0 x4 HS SSD	B58A	NVMe	Cache
ThinkSystem U.2 Intel P5600 6.4TB Mainstream NVMe PCIe 3.0 x4 HS SSD	B58B	NVMe	Cache
ThinkSystem M.2 650GB P4511 NVMe SED High Endurance SSD	B75C	NVMe	Cache
ThinkSystem 2.5” SS530 400GB Performance SAS 12Gb Hot Swap SSD	B4Y4	SSD	Cache
ThinkSystem 2.5” SS530 800GB Performance SAS 12Gb Hot Swap SSD	B4Y5	SSD	Cache
ThinkSystem 2.5” SS530 1.6TB Performance SAS 12Gb Hot Swap SSD	B4Y6	SSD	Cache
ThinkSystem 2.5” SS530 3.2TB Performance SAS 12Gb Hot Swap SSD	B4Y7	SSD	Cache
ThinkSystem 2.5" PM1645a 800GB Mainstream SAS 12Gb Hot Swap SSD	B8HU	SSD	Cache
ThinkSystem 2.5" PM1645a 1.6TB Mainstream SAS 12Gb Hot Swap SSD	B8J4	SSD	Cache
ThinkSystem 2.5" PM1645a 3.2TB Mainstream SAS 12Gb Hot Swap SSD	B8JD	SSD	Cache
ThinkSystem 2.5" Intel S4500 960GB Entry SATA 6Gb Hot Swap SSD	B0Z0	SSD	Capacity
ThinkSystem 2.5" Intel S4500 1.92TB Entry SATA 6Gb Hot Swap SSD	B0Z1	SSD	Capacity
ThinkSystem 2.5" Intel S4510 480GB Entry SATA 6Gb Hot Swap SSD	B499	SSD	Capacity
ThinkSystem 2.5" Intel S4510 960GB Entry SATA 6Gb Hot Swap SSD	B49A	SSD	Capacity
ThinkSystem 2.5" Intel S4510 1.92TB Entry SATA 6Gb Hot Swap SSD	B49B	SSD	Capacity
ThinkSystem 2.5" Intel S4510 3.84TB Entry SATA 6Gb Hot Swap SSD	B49C	SSD	Capacity
ThinkSystem 2.5" 5300 1.92TB Entry SATA 6Gb Hot Swap SSD	B8J5	SSD	Capacity
ThinkSystem 2.5" 5300 3.84TB Entry SATA 6Gb Hot Swap SSD	B8JP	SSD	Capacity
ThinkSystem 2.5" 5300 7.68TB Entry SATA 6Gb Hot Swap SSD	B8J2	SSD	Capacity
ThinkSystem 2.5" 5300 960GB Mainstream SATA 6Gb Hot Swap SSD	B8J6	SSD	Capacity
ThinkSystem 2.5" 5300 1.92TB Mainstream SATA 6Gb Hot Swap SSD	B8JE	SSD	Capacity
ThinkSystem 2.5" 5300 3.84TB Mainstream SATA 6Gb Hot Swap SSD	B8J7	SSD	Capacity
ThinkSystem 2.5" PM1645a 800GB Mainstream SAS 12Gb Hot Swap SSD	B8HU	SSD	Capacity
ThinkSystem 2.5" PM1645a 1.6TB Mainstream SAS 12Gb Hot Swap SSD	B8J4	SSD	Capacity
ThinkSystem 2.5" PM1645a 3.2TB Mainstream SAS 12Gb Hot Swap SSD	B8JD	SSD	Capacity
ThinkSystem 2.5" PM1643a 1.92TB Entry SAS 12Gb Hot Swap SSD	B91B	SSD	Capacity
ThinkSystem 2.5" PM1643a 3.84TB Entry SAS 12Gb Hot Swap SSD	B91C	SSD	Capacity
ThinkSystem 2.5" PM1643a 7.68TB Entry SAS 12Gb Hot Swap SSD	B91D	SSD	Capacity
ThinkSystem M.2 5300 480GB SATA 6Gbps Non-Hot Swap SSD	B919	SSD	Capacity
ThinkSystem M.2 5300 960GB SATA 6Gbps Non-Hot Swap SSD	B8JJ	SSD	Capacity
ThinkSystem M.2 5300 1.92TB SATA 6Gbps Non-Hot Swap SSD	BCNZ	SSD	Capacity
ThinkSystem M.2 1TB P4511 NVMe SED SSD	B75D	NVMe	Capacity

Storage Devices Used for All-Flash Solutions	Feature Code	Type	Usage
ThinkSystem M.2 2TB P4511 NVMe SED SSD	B75E	NVMe	Capacity

Note: Do not use a storage device for a purpose other than listed in the Usage column. For example, the Intel S4500 and S4510 SSDs have been certified for use only as a capacity device, so should not be used as a cache device.

Storage device end of life

More than any other component in a certified solution, the storage devices available are constantly changing as new, faster, larger devices are brought to market and previous generations reach their end of life. Table 5 provides details on which devices have reached or are nearing their projected end of life, including estimated last availability date and replacement device (if one is available).

Table 5 Storage device end of life summary

End of Life Device	Date	Replacement Device
ThinkSystem U.2 PX04PMB 960GB Mainstream 3.5" NVMe PCIe 3.0 x4 Hot Swap SSD	June 2018	None
PX04PMC 1.6TB Performance NVMe PCIe 3.0 x4 Flash Adapter (AIC)	June 2018	None
PX04PMC 3.2TB Performance NVMe PCIe 3.0 x4 Flash Adapter (AIC)	June 2018	None
PX04PMC 1.92TB Mainstream NVMe PCIe 3.0 x4 Flash Adapter (AIC)	June 2018	None
Intel S4500 SSD devices	September 2018	Intel S4510 SSD devices
Intel P4600 NVMe devices	March 2019	Intel P4610 NVMe devices
ThinkSystem 3.5" HUSMM32 Performance SAS 12Gb Hot Swap SSD	June 2019	ThinkSystem 3.5” SS530 Performance SAS 12Gb Hot Swap SSD
ThinkSystem 2.5" 5200 Mainstream SATA 6Gb Hot Swap SSD	August 2020	ThinkSystem 2.5" 5300 Mainstream SATA 6Gb Hot Swap SSD
ThinkSystem 3.5” SS530 Performance SAS 12Gb Hot Swap SSD	November 2020	ThinkSystem 3.5" PM1645a Mainstream SAS 12Gb Hot Swap SSD
ThinkSystem 2.5” SS530 Performance SAS 12Gb Hot Swap SSD	November 2020	ThinkSystem 2.5" PM1645a Mainstream SAS 12Gb Hot Swap SSD
ThinkSystem M.2 5100 SATA 6Gbps Non-Hot Swap SSD	February 2021	ThinkSystem M.2 5300 SATA 6Gbps Non-Hot Swap SSD
ThinkSystem U.2 Intel P4610 Mainstream NVMe PCIe 3.0 x4 HS SSD	July 2021	ThinkSystem U.2 Intel P5600 Mainstream NVMe PCIe 3.0 x4 HS SSD

GPU adapter support

Certain GPU adapters have been certified for use with Azure Stack HCI in Lenovo ThinkAgile MX solutions. Due to its small form factor, there are significantly more restrictions for solutions based on the SE350 server, as described below.

SR650-based solutions

Due to product end of life status of multiple GPUs previously available for SR650-based ThinkAgile MX solutions, the only GPU currently available is the NVIDIA Tesla T4 16GB PCIe Passive GPU (FC B4YB). Note that this is the same GPU that is supported for SE350-based ThinkAgile solutions.

SE350-based solutions

For ThinkAgile MX1020 and MX1021 solutions, the NVIDIA Tesla T4 16GB PCIe Passive GPU (FC B4YB) is supported for the SE350. However, since the GPU consumes the only available PCIe slot, only 4 SSD or NVMe devices can be configured in any SE350 server that includes a GPU.

Network switches

Network switches that we have tested in our labs include Lenovo and NVIDIA (Mellanox) switches. Although Lenovo no longer sells network switches, we include information about them here for customers who already own them. Mellanox switches must be ordered directly from NVIDIA.

NVIDIA/Mellanox network switches

Although NVIDIA/Mellanox switches are not orderable from Lenovo, the following Mellanox network switches have been tested with ThinkAgile MX solutions and proper switch functionality has been verified:

NVIDIA MSN2010-CB2F Spectrum Based 25GbE/100GbE with Onyx OS
1U, Half-Width Open Ethernet switch with 18 SFP28 and 4 QSFP28 Ports
https://www.mellanox.com/sites/default/files/doc-2020/br-sn2000-series.pdf
https://www.mellanox.com/sites/default/files/doc-2020/pb-sn2010.pdf

NVIDIA MSN2410-CB2F Spectrum Based 25GbE/100GbE with Onyx OS
1U, Full-Width Open Ethernet switch with 48 SFP28 Ports 8 QSFP28 Ports
https://www.mellanox.com/sites/default/files/doc-2020/br-sn2000-series.pdf
https://www.mellanox.com/sites/default/files/doc-2020/pb-sn2410.pdf

NVIDIA MSN3700-CS2F Spectrum-2 Based 100GbE with Onyx OS
1U, Full-Width Open Ethernet switch with 32 QSFP28 Ports
https://www.mellanox.com/files/doc-2020/br-sn3000-series.pdf

Lenovo network switches

Lenovo network switches are no longer being offered. The information contained in this section is provided in case customers want to verify that their existing Lenovo switches can be used for an Azure Stack HCI solution.

Although network switches are not specifically certified under the Microsoft HCI certification programs, all of the Lenovo certified configurations for Microsoft HCI discussed in this document have undergone rigorous end-to-end solution validation using Lenovo network switches to carry all solution traffic.

Table 7 lists the recommended Lenovo networking switches for S2D deployment. These switches support the Remote Direct Memory Access (RDMA) feature of Microsoft SMB 3.x, which is used extensively by S2D and are fully compatible with the Mellanox ConnectX-4 Lx network adapters used in these solutions to provide the highest storage performance.

Table 6 Recommended Lenovo network switches for S2D

Lenovo Switch	Speed	Part Number	Feature Code
RackSwitch™ G8272	10GbE	7159CRW/7159CFV	ASRD/ASRE
ThinkSystem NE1032 RackSwitch	10GbE	7159A1X/7159A2X	AU3A/AU39
ThinkSystem NE2572 RackSwitch	10/25GbE	7159E1X/7159E2X	AV19/AV1A
ThinkSystem NE10032 RackSwitch	100GbE	7159D1X/7159D2X	AV17/AV18

Note: The first part number and feature code listed in Table 7 is for a switch with rear to front airflow. The second part number and feature code is for front to rear airflow.

RackSwitch G8272

The Lenovo RackSwitch G8272 uses 10 Gb SFP+ and 40 Gb QSFP+ Ethernet technology and is specifically designed for the data center. It is ideal for today's big data, cloud, and optimized workload solutions. It is an enterprise class Layer 2 and Layer 3 full featured switch that delivers line-rate, high-bandwidth switching, filtering, and traffic queuing without delaying data. Large data center-grade buffers help keep traffic moving, while the hot-swap redundant power supplies and fans (along with numerous high-availability features) help provide high availability for business sensitive traffic. In addition to the 10GbE and 40GbE connections, the G8272 can use 1GbE connections.

ThinkSystem NE1032 RackSwitch

The Lenovo ThinkSystem NE1032 RackSwitch is a 1U rack-mount 10 GbE switch that delivers lossless, low-latency performance with feature-rich design that supports virtualization, Converged Enhanced Ethernet (CEE), high availability, and enterprise class Layer 2 and Layer 3 functionality. The switch delivers line-rate, high-bandwidth switching, filtering, and traffic queuing without delaying data. The NE1032 RackSwitch has 32x SFP+ ports that support 1 GbE and 10 GbE optical transceivers, active optical cables (AOCs), and DACs. The switch helps consolidate server and storage networks into a single fabric, and it is an ideal choice for virtualization, cloud, and enterprise workload solutions.

ThinkSystem NE2572 RackSwitch

The Lenovo ThinkSystem NE2572 RackSwitch is designed for the data center and provides 10/25 GbE connectivity with 40/100 GbE upstream links. It is ideal for big data, cloud, and enterprise workload solutions. It is an enterprise class Layer 2 and Layer 3 full featured switch that delivers line-rate, high-bandwidth switching, filtering, and traffic queuing without delaying data. Large data center-grade buffers help keep traffic moving, while the hot-swap redundant power supplies and fans (along with numerous high-availability software features) help provide high availability for business sensitive traffic. The NE2572 RackSwitch has 48x SFP28/SFP+ ports that support 10 GbE SFP+ and 25 GbE SFP28 optical transceivers, AOCs, and DACs. The switch also offers 6x QSFP28/QSFP+ ports that support 40 GbE

QSFP+ and 100 GbE QSFP28 optical transceivers, AOCs, and DACs. These ports can also be split out into four 10 GbE (for 40 GbE QSFP+) or 25 GbE (for 100 GbE QSFP28) connections by using breakout cables.

ThinkSystem NE10032 RackSwitch

The Lenovo ThinkSystem NE10032 RackSwitch uses 100 Gb QSFP28 and 40 Gb QSFP+ Ethernet technology and is specifically designed for the data center. It is ideal for today's big data, cloud, and enterprise workload solutions. It is an enterprise class Layer 2 and Layer 3 full featured switch that delivers line-rate, high-bandwidth switching, filtering, and traffic queuing without delaying data. Large data center-grade buffers help keep traffic moving, while the hot-swap redundant power supplies and fans (along with numerous high-availability features) help provide high availability for business sensitive traffic. The NE10032 RackSwitch has 32x QSFP+/QSFP28 ports that support 40 GbE and 100 GbE optical transceivers, AOCs, and DACs. These ports can also be split out into four 10 GbE (for 40 GbE ports) or 25 GbE (for 100 GbE ports) connections by using breakout cables.

Other recommendations

We also recommend the features and upgrades in this section to maximize the security and manageability of the S2D solution built using the Lenovo certified configurations discussed in this document.

TPM 2.0 and Secure Boot

Trusted Platform Module (TPM) is an international standard for a secure cryptoprocessor, a dedicated microcontroller designed to secure hardware through integrated cryptographic keys. TPM technology is designed to provide hardware-based, security-related functions and is used extensively by Microsoft in Windows Server 2019 technologies including BitLocker, Device Guard, Credential Guard, UEFI Secure Boot, and others. **There is no additional cost to enable TPM 2.0** on Lenovo ThinkSystem servers. For the SR650, order Feature Code AUK7.

ThinkSystem XClarity Controller Standard to Enterprise Level

The Lenovo XClarity™ Controller is the next generation management controller that replaces the baseboard management controller (BMC) for Lenovo ThinkSystem servers. Although the XCC Standard Level includes many important manageability features, we recommend upgrading to the XCC Enterprise Level of functionality. This enhanced set of features includes Virtual Console (out of band browser-based remote control), Virtual Media mounting, and other remote management capabilities. For the SR650, order Feature Codes B173.

Lenovo XClarity Pro

Lenovo XClarity Administrator (LXCA) is a centralized resource management solution that is aimed at reducing complexity, speeding response, and enhancing the availability of Lenovo server systems and solutions. LXCA provides agent-free hardware management for our servers, storage, network switches, hyperconverged and ThinkAgile solutions. Lenovo XClarity Pro offers additional functionality that provide important benefits to managing a Microsoft S2D cluster solution. For more information, see the LXCA Product Guide at the following URL:

https://lenovopress.com/tips1200-lenovo-xclarity-administrator

Lenovo RackSwitch Adjustable 19" 4-Post Rail Kit

If you intend to purchase Lenovo network switches for your S2D HCI solution, we highly recommend the optional 4-Post Rail Kit to increase stability of these switches when mounted in a rack. Order Feature Code A3KP.

Summary

Lenovo is a key partner in the Microsoft WSSD and Azure Stack HCI programs for certification of HCI solutions. Based on Lenovo's investment in these programs and the tremendous amount of time, resources, and effort dedicated to certification and validation testing for each certified configuration discussed in this document, our customers can rest assured that the configurations presented will perform smoothly and reliably right out of the box.

This document has provided some background information related to the Microsoft WSSD and Azure Stack HCI programs, as well as details of Lenovo certified configurations that have been certified and validated under the program to run Storage Spaces Direct. Selecting from the list of Lenovo certified configurations found in this document to build an S2D HCI solution will save time, money, and effort associated with designing and building a do-it-yourself solution that could be riddled with issues.

We will add more examples of Lenovo certified configurations for Microsoft HCI solutions to this document as additional certifications are completed.

Change History

Changes in the July 2021 update:

- Updated the list of GPUs supported in ThinkAgile MX solutions in "GPU adapter support" on page 28
- Updated storage device EOL table (Table 5 on page 27)

Changes in the April 2021 update:

- Added notes regarding support for NVIDIA T4 GPU in ThinkAgile MX1020 and MX1021 solutions
- Added section "NVIDIA/Mellanox network switches" on page 28 that provides details regarding NVIDIA (Mellanox) network switches that have been tested with ThinkAgile MX solutions
- Added the ThinkAgile MX1020 on SE350 Appliance to the notes included under "Special considerations for ThinkAgile MX1020 and MX1021 on SE350" on page 21

Changes in the February 2021 update:

- Updated all-flash storage device table (Table 4 on page 25) with new supported drives for SE350-based ThinkAgile MX solutions
- Updated storage device EOL table (Table 5 on page 27)

Changes in the January 2021 update:

- Corrected GPUs shown in Table 6

Changes in the December 2020 update:

- Added a brief description of ThinkAgile MX Appliance offerings in “ThinkAgile MX Appliance” on page 7
- Added “GPU adapter support” on page 28 to provide information regarding GPU adapter support for ThinkAgile MX solutions
- Updated storage device tables (Table 3 on page 25 and Table 4 on page 25) with new supported drives
- Removed supported OS boot devices from storage device tables
- Added supported OS boot devices to “Component selection” on page 23

Changes in the August 2020 update:

- Added reference to Lenovo Press document *ThinkAgile MX1021 on SE350 Azure Stack HCI (S2D) Deployment Guide*
- Updated configuration details for some all-flash configurations, since the Cavium/QLogic 25GbE network adapter has now been certified for these configurations
- Added Mellanox ConnectX-6 HDR100 QSFP56 PCIe InfiniBand Adapters (1-port and 2-port models) as supported and certified network adapters for high performance all-flash configurations
- Added the SE350 Wireless Network Module as a supported and certified network module for ThinkAgile MX1021 on SE350
- Updated storage device tables (Table 3 on page 25 and Table 4 on page 25) with new supported drives and removed devices that are no longer available
- Updated storage device tables (Table 3 on page 25 and Table 4 on page 25) to include boot device
- Updated Table 5 on page 27 with additional storage devices that have or will soon reach their end of life

Changes in the May 2020 update:

- Added ThinkAgile MX1021 on SE350 to the ThinkAgile MX Certified Nodes family, including example configurations NN16T1a (single-tier all-NVMe), NN12T1a (two-tier all-NVMe), and SS08T1a (single-tier all-SSD)
- Added a section that discusses special configuration details for the ThinkSystem SE350 Edge Server in ThinkAgile MX1021 on SE350 solutions
- Added supported data storage devices to Table 4 for ThinkAgile MX1021 on SE350

Changes in the October 2019 update:

- Changed the document title to accurately reflect Microsoft’s change of “Storage Spaces Direct” to “Azure Stack HCI”
- Added multiple comments, mainly in “Component selection” on page 23, regarding the Lenovo ThinkSystem SE350, which has been certified for Azure Stack HCI, but is not yet offered as a ThinkAgile MX Certified Node

Changes in the July 2019 update:

- Replaced NS58T1a all-flash configuration with NS61T1a to ensure the number of capacity devices (16) is an equal multiple of cache devices (4)
- Added an All-SSD configuration example (SS92T1a)
- Added an All-NVMe configuration example (NN38T1a)
- Updated storage device tables

- Corrected typos and updated graphics for accuracy

Changes in the March 2019 update:

- Added information about the Microsoft Azure Stack HCI program
- Added Lenovo ThinkSystem SR630 as a certified general purpose server
- Added ThinkSystem 3.5” Intel P4610 NVMe devices as replacements for P4600 devices
- Added ThinkSystem U.2 Intel P4610 NVMe devices as replacements for P4600 devices

Changes in the December 2018 update:

- Clarified the availability of ThinkAgile MX Certified Nodes configuration in the Lenovo Data Center Solution Configurator
- Removed configuration SH32T1a, since it is exactly the same as SH40T1a with fewer HDD capacity devices

Changes in the November 2018 update:

- Added ThinkAgile MX Certified Node description and details
- Updated the layout for Table 1 on page 8 to improve readability
- Added 1-port Mellanox NIC as an option if two 1-port NICs are preferred
- Added section “Small cluster configurations” on page 20 to provide additional detail for these configurations
- Added ThinkSystem 430-8i SAS/SATA 12Gb HBA for all-flash configurations
- Split storage device table into two tables, one for Hybrid Storage configs (Table 3 on page 25) and one for All-Flash configs (Table 4 on page 25)
- Added section “Storage device end of life” on page 27 to indicate devices nearing their end of life

Changes in the August 2018 update:

- Added Cavium/QLogic network adapter to the list of certified NICs
- Updated Nodes column in Table 1 on page 8, including 2-node and 16-node configurations
- Updated certified storage devices shown in Table 3 on page 25
- Updated processor selection criteria in the “USB file share witness” on page 21

Changes in the May 2018 update:

- Added configuration SR650-NH120T1a
- Updated document title and content regarding certified configurations

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