



Reference Architecture: Hybrid Cloud Solution with VMware Cloud Foundation on ThinkAgile VX and Azure VMware Services

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Version 1.02

Operate and manage workloads on-prem and in the cloud

Leverages Azure VMware Services for the public cloud services

Contains configurations for three application scenarios

Offers several use cases for the hybrid cloud solution

Luke Huckaba



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1 Introduction

This document outlines the reference architecture for a Hybrid Cloud using VMware Cloud Foundation (VCF) on Lenovo ThinkAgile VX servers. It offers a turnkey hybrid cloud solution, combining Lenovo hardware, VMware software with Lenovo XClarity integration, and Azure VMware Solution (AVS) to provide customers with an automated hyperconverged infrastructure with easy management. The document also provides a starting point for the different components and hardware configurations available to the customer.

This reference architecture is intended for IT professionals with varying levels of VMware expertise who are responsible for designing and implementing VMware-based Software-Defined Datacenters (SDDCs) in both on-premises deployments and hybrid cloud architecture. The audience will benefit from having a base understanding of the VMware SDDC stack, including vCenter, ESXi, vSAN, NSX, as well as familiarity with deploying cloud components in Microsoft Azure. While some exposure to Lenovo's tools such as XClarity Controller, XClarity Administrator, or XClarity Integrator can be helpful, it is not a prerequisite for understanding and utilizing this reference architecture document.

The accompanying [deployment guide](#) is specifically created to assist users in navigating the deployment process, providing step-by-step instructions and guidance. It aims to bridge any knowledge gaps by offering clear explanations and illustrations, making it easier for users to implement the hybrid cloud solution using Lenovo ThinkAgile VX servers.

An [upgrade guide](#) is also available on the VMware site that covers the steps to upgrade an existing VMware Software Defined Datacenter (SDDC) deployed using VMware Cloud Foundation 4.5.1, with Lenovo integrations, to VCF 5.0. The guide ensures that customer environments remain accessible with no downtime for workloads running on the cluster being upgraded.

1.1.1 Version history:

1. V1.0 – August 21, 2023
2. V1.1 - October 20, 2023: Added information on the upgrade guide for VCF 4.5.1
3. V1.2 – March 21, 2024: Updated Premier Support with ThinkAgile VX Integrated Systems

2 Architectural overview

This design references three configurations for the on-premises deployment:

- **General Purpose** - Provide a balance of compute, memory, storage and networking resources, and can be used for a variety of diverse workloads. This design is ideal for applications that use resources in equal proportions.
- **Compute Optimized** - Ideal for CPU-bound applications that benefit from high performance processors. Instances belonging to this family are well suited for batch processing workloads, media transcoding, high performance web servers, scientific modelling, dedicated gaming servers and ad server engines, machine learning inference and other compute intensive applications.
- **Storage Optimized** - Designed for workloads that require high, sequential read and write access to very large data sets on local storage, with the ability to scale out storage decoupled from compute.

The software is the same across all three with changes made to the following components: higher core count CPU and increased RAM on Compute Optimized; and external storage to scale out capacity outside of compute on Storage Optimized. These configurations are recommended starting points and not a strict requirement or limitation. Please review Lenovo's VMware-certified components to customize configurations as needed. Microsoft Azure will be the public cloud instance for this reference architecture.

2.1 VCF Architecture Conceptual Design

VMware Cloud Foundation (VCF) can be deployed in two architectures: Standard & Consolidated.

The **Standard Architecture** (*Figure 1*) consists of a Management Domain, which is an independent vSphere cluster with its own vCenter and NSX Manager cluster, where the management components will be physically separated from the workload VMs. The management components consist of SDDC Manager, all vCenter Servers for both management and workloads, NSX Manager clusters for both management and workloads, and NSX Edge cluster(s) for management only. Additional VI Workload Domains can be deployed consisting of their own compute cluster(s), NSX Management cluster(s) (hosted in the Management Domain), separate vCenter(s), and a separate NSX edge cluster(s), leveraging vSAN as the storage. Though vSAN is required for the Management Domain, Workload Domains support the option to leverage vSAN, NFS, or Fibre Channel as the shared storage in the cluster.

Each "domain" is a physically separate cluster vSphere cluster. This ensures there is no resource contention for the management components of the environment. For simplicity, Lenovo XClarity depicted in **Figures 1-5** represents both Lenovo XClarity Administrator and Lenovo XClarity Integrator for VMware vCenter.

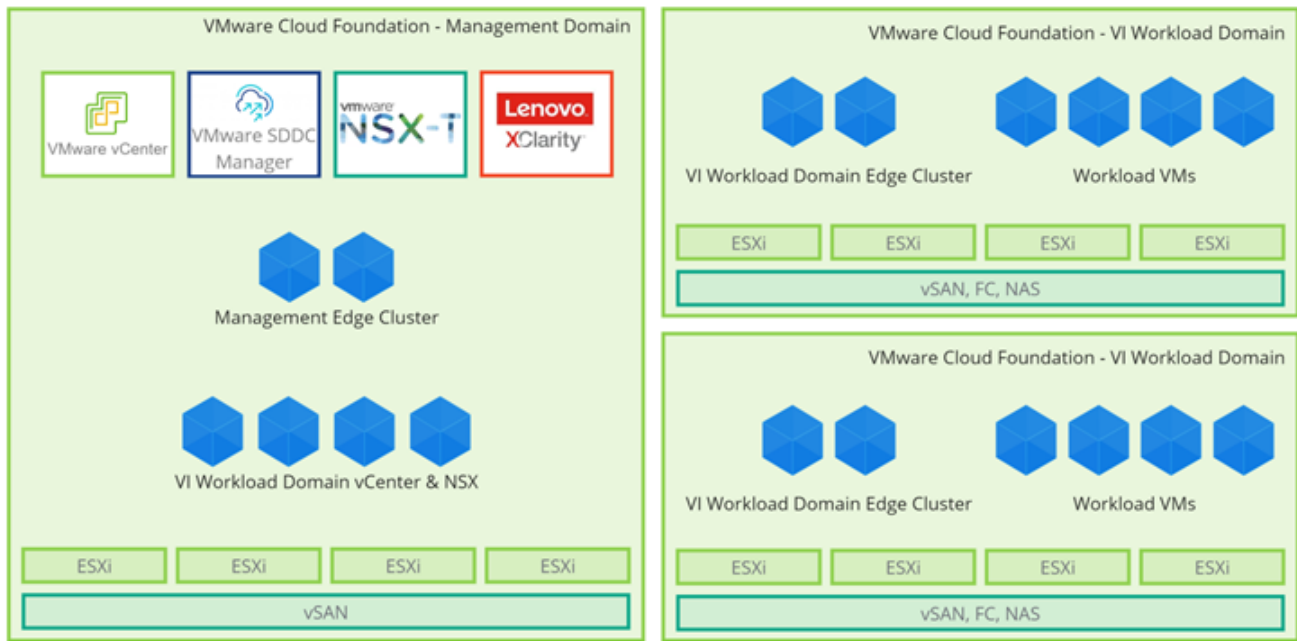


Figure 1: Standard Architecture conceptual design

The **Consolidated Architecture** (*Figure 2*) deploys the same components, but all within a single physical cluster. The management components are logically protected inside a management resource pool. This is one of the key differences between the Standard Architecture and the Consolidated Architecture, as there are no resource pools in the Standard Architecture since no workload VMs should be deployed in the management domain.

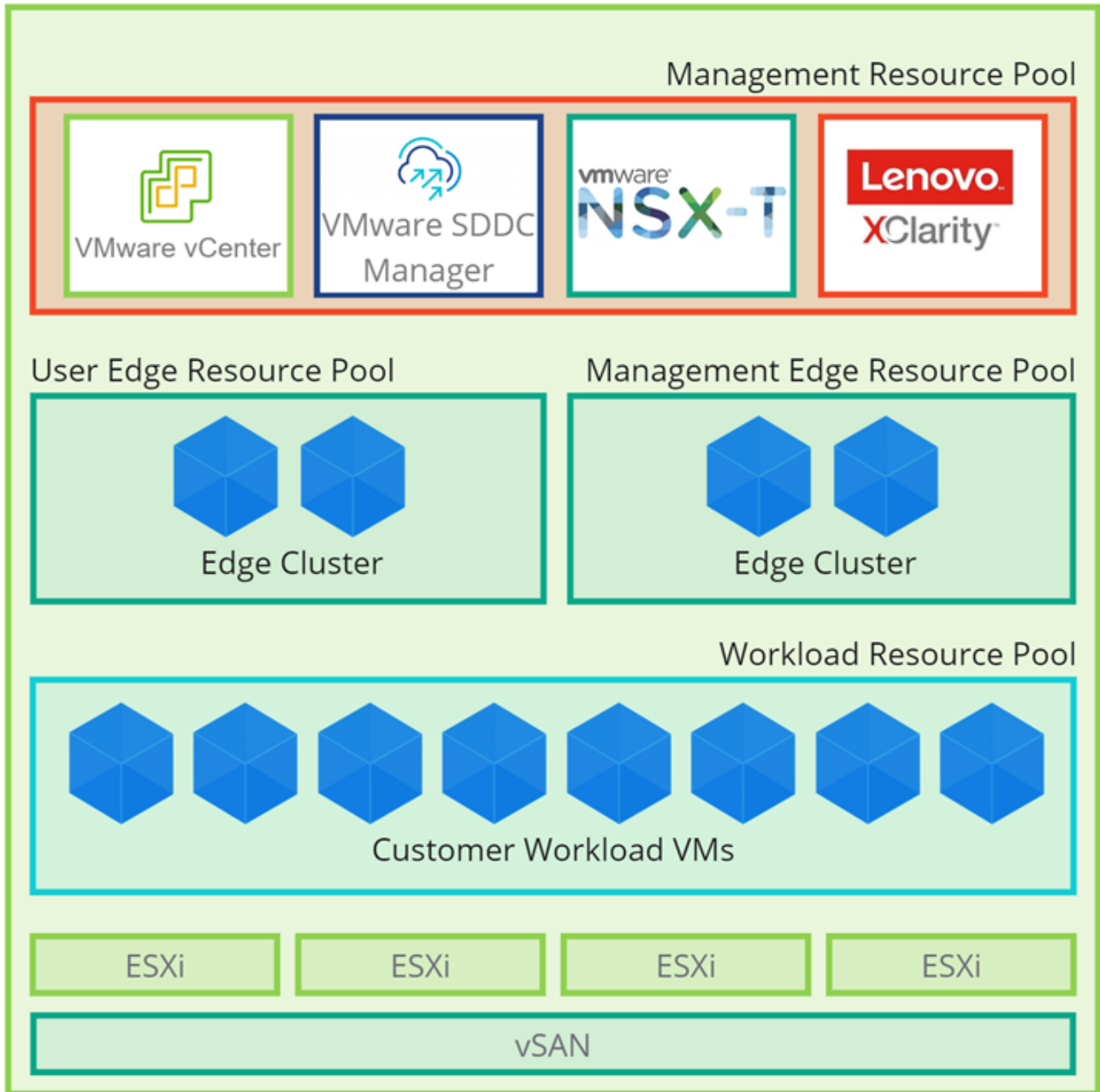


Figure 2: Consolidated Architecture conceptual design

Customers may choose to deploy additional vSphere clusters within the Consolidated Architecture, as well as expand the environment by adding additional VI Workload Domains similar to the Standard Architecture.

Each additional VI Workload Domain that is created with its own vCenter joins the Management Domain's SSO domain. This ensures a single pane of glass to manage all Workload Domains, and also provides the ability to limit access through Role Based Access Control for specific users, or groups of users, to their respective Workload Domain.

2.2 Physical Design

This reference architecture will cover, at a high level, three configurations of the physical components. Two of these configurations relate to the amount of compute in the physical server (**General Purpose** and **Compute Optimized**) and one with external storage (**Storage Optimized**). The General Purpose and Compute Optimized configurations leverage the Consolidated Architecture, while the Storage Optimized configuration leverages the Standard Architecture.

2.2.1 General Purpose

The General Purpose configuration (*Figure 3*) is a baseline that serves as a starting point for general workloads in any environment. This configuration consists of a VCF Consolidated Architecture where the management and infrastructure VMs run in the same physical cluster as the workload VMs. The two components are separated into their own Resource Pools to provide a level of separation to avoid resource contention.

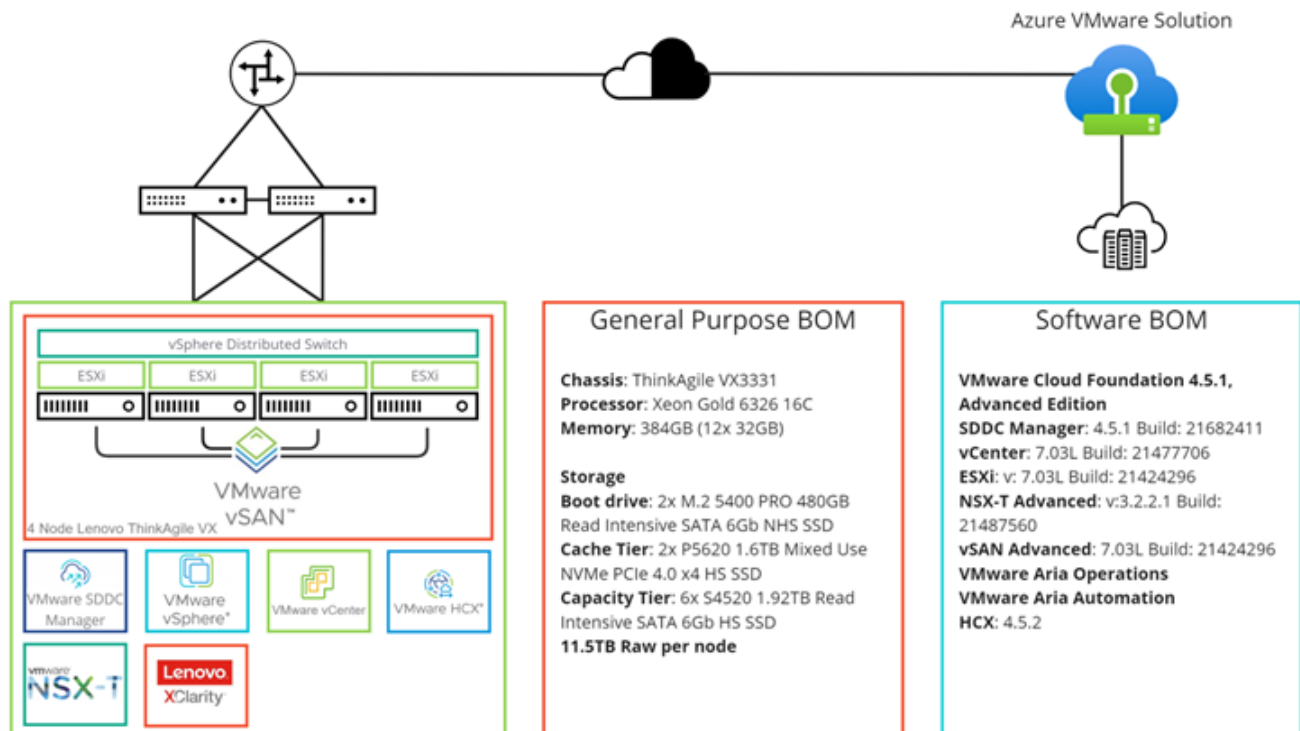


Figure 3: General Purpose conceptual design

2.2.2 Compute Optimized

The Compute Optimized configuration (*Figure 4*) follows the model of the General Purpose configuration but increases the core count from 16 cores per CPU to 24, as well as doubles the amount of RAM per server from 384GB to 768GB. This configuration is an example for workloads that may consist of larger VMs that are CPU intensive or require data to live in memory of the VM.

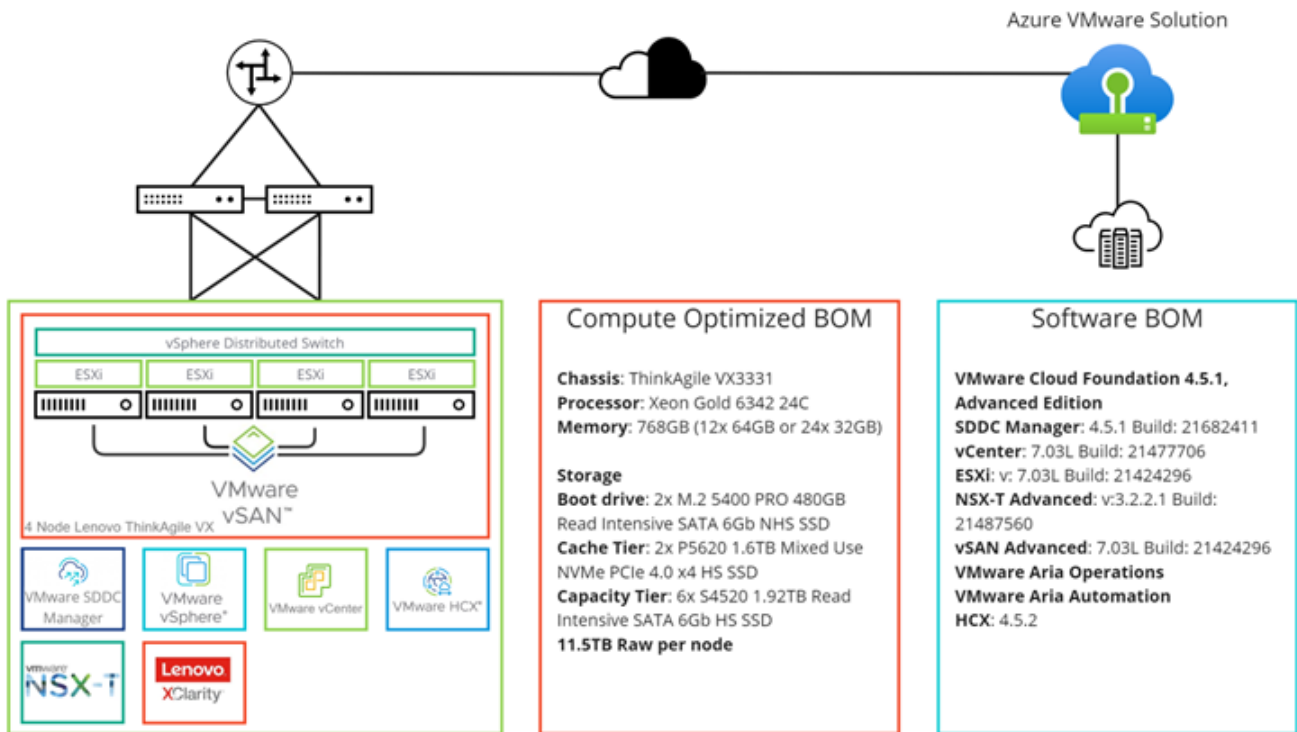


Figure 4: Compute Optimized conceptual design

2.2.3 Storage Optimized

The Storage Optimized configuration (Figure 5) includes the same hardware and software components as the General Purpose configuration, but leverages VCF's Standard Architecture consisting of a separate Management Domain (where all management and infrastructure VMs will run) and a separate Workload Domain (that is dedicated to all workload VMs). This configuration adds the ability to scale out storage decoupled from compute by including external storage with the Lenovo ThinkSystem DM5000H unified hybrid storage system.

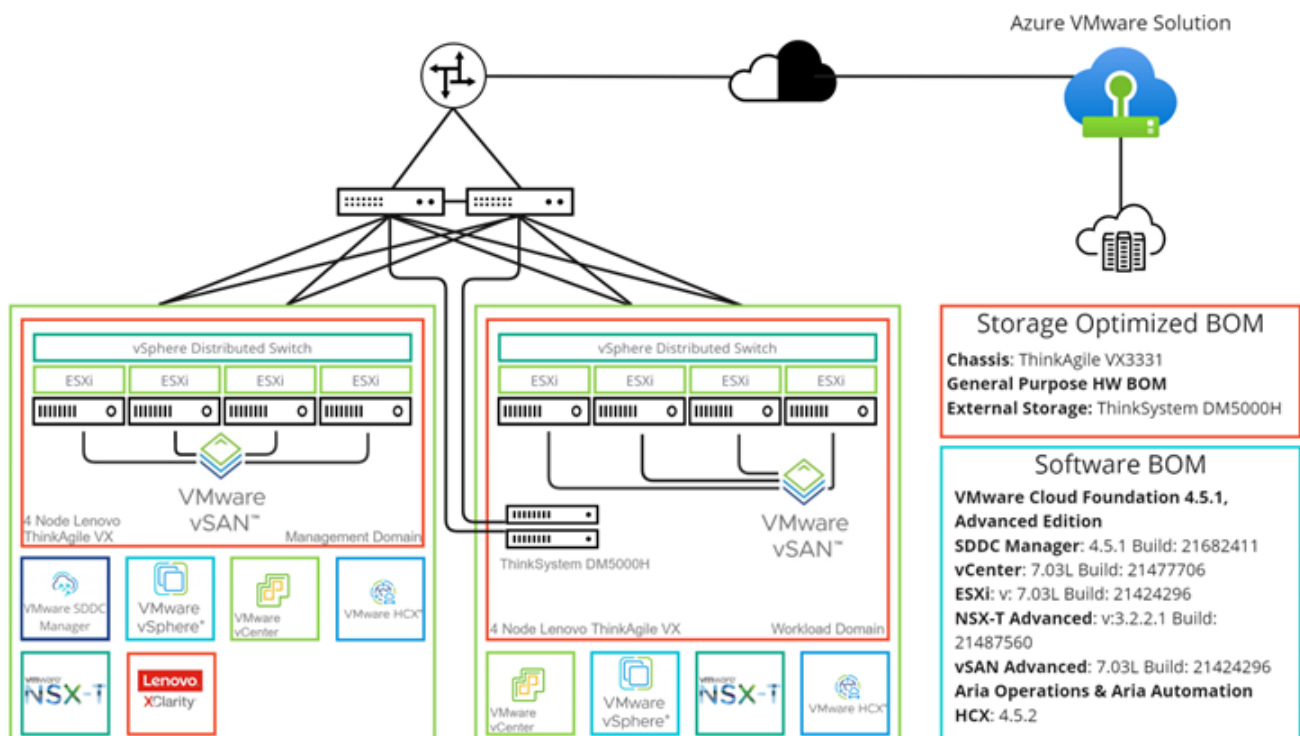


Figure 5: Storage Optimized conceptual design

2.3 Software components

This solution leverages enterprise virtualization software to automate the deployment and lifecycle of the entire software defined datacenter (SDDC). Lenovo's ThinkAgile VX certified node provides a robust and flexible hardware platform that is tightly integrated into VMware through Lenovo's XClarity suite of tools. Firmware repositories are created in Lenovo XClarity Administrator to specify desired versions to match VMware's compatibility list, deploy an ESXi image that matches the required build number for VCF, but also includes Lenovo's customizations to provide device drivers. Integration between Lenovo XClarity Administrator and VMware is provided through Lenovo XClarity Integrator for VMware vCenter. This integration brings the ability to manage the Lenovo servers directly in the vCenter interface VMware administrators are accustomed to using, as well as provide a topology view of the Lenovo servers.

This design consists of the following components and their specific versions and/or build numbers:

- VMware components
 - VMware Cloud Foundation 4.5.1, Advanced Edition
 - Cloud Builder 4.5.1, build 21682411*
 - SDDC Manager 4.5.1, build 21682411
 - vCenter 7.0 u3L, build 21477706
 - ESXi 7.0 u3L, build 21424296
 - vSAN Advanced 7.0 u3L, build 21424296
 - NSX-T Advanced 3.2.2.1, build 21487560

- VMware Aria**
 - ❖ VMware Aria Operations
 - ❖ VMware Aria Automation
 - HCX 4.5.2
 - Lenovo Components
 - Lenovo XClarity Administrator 4.03
 - Lenovo XClarity Integrator for VMware vCenter 8.2.0
 - Microsoft Azure Cloud
 - Microsoft Azure VMware Solution

*Cloud Builder is only used during the initial bring-up process and can be deleted post-deployment.

**The VMware Cloud Foundation Bill of Materials (BOM) for version 4.5.1 includes vRealize Suite Lifecycle Manager to deploy & manage the vRealize Suite of tools. Customers may choose to deploy the vRealize Suite in their on-premises environment and connect them to their hybrid cloud components. This reference architecture leverages the hosted VMware Aria Software-as-a-Service (SaaS) cloud-based model for ease of deployment and manageability.

Note: VMware Aria includes additional components that are not utilized as part of this design.

2.3.1 Lenovo XClarity Administrator

Lenovo XClarity Administrator (LXCA) is a comprehensive and intuitive management solution designed to simplify and streamline the management of Lenovo server infrastructure. With a centralized interface, administrators can efficiently monitor, configure, and troubleshoot Lenovo servers, chassis, and networking components. LXCA offers features such as inventory management, automated firmware updates, proactive system health monitoring, and automated operating system deployment, ensuring consistent configurations and reducing manual effort. This powerful tool enhances operational efficiency, reduces downtime, and provides organizations with robust server management capabilities, ultimately optimizing the management of their Lenovo server infrastructure.

2.3.2 Lenovo XClarity Integrator for VMware vCenter

Lenovo XClarity Integrator for VMware vCenter (LXCI) is a powerful plugin that seamlessly integrates Lenovo server management capabilities into the VMware vCenter management platform. This integration provides administrators with a unified interface to monitor, manage, and troubleshoot Lenovo servers directly from the vCenter environment. LXCI enhances operational efficiency by enabling administrators to perform tasks such as inventory management, firmware updates, and hardware health monitoring without needing to switch

between different management consoles. It provides a holistic view of Lenovo server infrastructure within the VMware vCenter, simplifying the management process and optimizing resource utilization. With LXCI, organizations can leverage the benefits of both Lenovo server management and VMware virtualization, streamlining operations and improving the overall management experience.

2.3.3 VMware Cloud Foundation

VMware Cloud Foundation is a software platform that enables the deployment of hybrid cloud infrastructure. It is designed to simplify the process of building and managing cloud environments by providing a common operational model across private and public clouds. At its core, VMware Cloud Foundation is based on the VMware vSphere virtualization platform, which provides a foundation for building virtualized data centers. In addition, it includes VMware vSAN for software-defined storage, and NSX for software-defined networking. One of the key benefits of VMware Cloud Foundation is its ability to provide consistent infrastructure and operations across multiple clouds, including on-premises private clouds and public clouds, such as Microsoft Azure. This allows organizations to take advantage of the benefits of cloud computing, such as scalability and agility, while also maintaining control over their data and applications.

2.3.4 VMware Cloud Builder

VMware Cloud Builder is a software tool that is used to automate the deployment of VMware Cloud Foundation. It is designed to simplify the process of setting up and configuring a VMware Cloud Foundation environment, reducing the time and effort required for manual installation and configuration. Using VMware Cloud Builder, administrators can define the desired configuration of the VMware Cloud Foundation environment, including the number and type of hosts, the network topology, and the configuration of storage and compute resources. The tool then automates the process of deploying and configuring the environment, ensuring that it is set up according to the specified requirements. One of the key benefits of VMware Cloud Builder is that it helps to reduce the risk of errors and inconsistencies that can arise from manual installation and configuration. By automating the process, administrators can ensure that the environment is set up consistently and correctly, reducing the risk of downtime or other issues.

2.3.5 VMware SDDC Manager

VMware SDDC Manager is a comprehensive software solution designed to simplify and streamline the management of Software-Defined Data Centers (SDDCs). It serves as a central control plane, providing administrators with a unified interface to deploy, operate, and monitor the entire SDDC infrastructure. SDDC Manager automates tasks such as software patching, upgrades, and lifecycle management, ensuring consistent and efficient operations across compute, storage, and networking resources. With its intelligent management capabilities, SDDC Manager enables organizations to achieve greater agility, scalability, and reliability in their virtualized data center environments.

2.3.6 VMware vCenter

VMware vCenter is a powerful and centralized management platform that enables organizations to effectively manage and control their virtualized infrastructure. Acting as a virtualization management hub, vCenter provides a comprehensive set of tools for administrators to provision, monitor, and manage virtual machines, hosts, and clusters in their data centers. With vCenter, administrators can easily configure networking, and storage, ensuring optimal performance and resource allocation. It offers features such as High Availability (HA), Fault Tolerance (FT), and Distributed Resource Scheduler (DRS), enhancing the reliability and efficiency of virtualized environments. In summary, vCenter empowers organizations to efficiently manage their virtual infrastructure, streamline operations, and maximize the benefits of virtualization technology.

2.3.7 VMware ESXi

VMware ESXi is a highly efficient and reliable hypervisor that forms the foundation of virtualization in VMware's software-defined data center (SDDC) stack. ESXi is a bare-metal hypervisor, meaning it runs directly on server hardware without the need for an underlying operating system. It enables the virtualization of compute resources, allowing multiple virtual machines to run concurrently on a single physical server. ESXi provides robust features such as memory management, CPU scheduling, and device virtualization, ensuring optimal performance and resource allocation for virtualized workloads. With its advanced security measures, including isolation and secure boot, ESXi helps protect virtual machines and the overall data center environment from potential threats. Overall, ESXi is a key component of VMware's virtualization infrastructure, delivering scalability, efficiency, and flexibility for organizations seeking to leverage the benefits of virtualization technology.

VMware vSphere integrates VMware vCenter for centralized management and VMware ESXi as the hypervisor, collectively offering a comprehensive virtualization and cloud solution. VMware vSphere is a powerful virtualization and cloud platform that helps organizations efficiently manage IT resources. By creating virtual machines, it optimizes server use, lowers costs, and boosts scalability. It also offers high availability, cloud integration, and resource controls for enhanced performance and adaptability, making it an essential tool for modern IT management.

2.3.8 VMware vSAN

VMware vSAN is a feature-rich software-defined storage solution seamlessly integrated into the VMware vSphere virtualization platform, making it a key component of hyperconverged infrastructure. By pooling and utilizing the local storage resources of vSphere hosts, vSAN enables the creation of a highly scalable and resilient shared storage infrastructure. This eliminates the need for traditional storage arrays and allows organizations to achieve the benefits of hyperconverged infrastructure. With vSAN, storage capacity and performance are aggregated across the vSphere cluster, delivering advanced features such as data deduplication, compression, and erasure coding to enhance storage efficiency. vSAN also provides policy-based management, automated tiering, and stretched clusters, ensuring high availability and seamless operations in distributed environments. By integrating storage directly into the virtualization platform, vSAN

simplifies storage provisioning, management, and monitoring, making it an ideal choice for organizations seeking to implement hyperconverged infrastructure.

2.3.9 VMware NSX

VMware NSX is a software-defined networking (SDN) and network virtualization platform that brings agility, security, and scalability to modern data center networks. NSX enables organizations to create virtual networks and network services entirely in software, decoupled from the underlying physical infrastructure. It abstracts and reproduces the entire networking and security environment, allowing for the provisioning, management, and automation of network services in a flexible and programmable manner. NSX offers a range of advanced networking capabilities, including virtualized switches, routers, firewalls, load balancers, and VPNs, all operated and controlled centrally through a management console. With NSX, organizations can achieve microsegmentation, isolating and securing workloads at a granular level, enhancing network security and compliance. Additionally, NSX integrates with existing networking and security infrastructure, providing seamless connectivity and extending the benefits of virtualization across hybrid cloud environments. Overall, VMware NSX empowers organizations to create dynamic and secure networks, accelerating application deployment, improving network agility, and simplifying network management.

2.3.10 VMware Aria

VMware Aria is a comprehensive cloud management platform that provides organizations with a set of integrated tools and capabilities for managing and automating their hybrid cloud environments. With VMware Aria, organizations can gain visibility, control, and optimization of their cloud infrastructure, applications, and services. It offers features such as self-service provisioning, resource management, cost optimization, performance monitoring across multiple cloud platforms, and carbon footprint visibility. VMware Aria enables organizations to streamline operations, improve efficiency, and ensure compliance through centralized management and automation of cloud resources. By providing a unified and extensible platform, VMware Aria empowers organizations to accelerate their cloud adoption journey, optimize resource utilization, and deliver enhanced services to their users.

2.3.11 VMware Aria Operations

VMware Aria Operations is a powerful management and monitoring solution designed to provide comprehensive visibility, performance optimization, and proactive intelligence for virtualized and cloud environments. It offers organizations deep insights into their infrastructure, applications, and workloads, allowing them to optimize resource utilization, troubleshoot issues, and ensure the performance and health of their environment. With advanced analytics, capacity planning, and automated remediation capabilities, VMware Aria Operations enables administrators to proactively identify and resolve potential problems, streamline operations, and ensure efficient resource allocation. It provides a unified and centralized platform for monitoring and managing hybrid cloud environments, empowering organizations to deliver reliable and high-performing services to their users.

2.3.12 VMware Aria Automation

VMware Aria Automation is a powerful cloud automation and orchestration platform that enables organizations to accelerate and simplify the process of delivering and managing applications and infrastructure. With VMware Aria Automation, organizations can automate the entire lifecycle of their IT services, from self-service provisioning and deployment to ongoing management and governance. It offers a rich set of features, including customizable blueprints, policy-driven governance, and integration with external systems, allowing for seamless automation and orchestration across hybrid cloud environments. VMware Aria Automation empowers IT teams to rapidly deliver infrastructure and applications, improve agility, and enforce consistent governance, while providing end-users with self-service access to IT resources. By automating and streamlining IT service delivery, VMware Aria Automation helps organizations drive efficiency, reduce costs, and accelerate innovation.

2.3.13 VMware HCX

VMware HCX is a powerful solution designed to simplify and accelerate workload mobility between on-premises data centers and public cloud environments. HCX enables seamless migration and interconnectivity of applications and workloads across different cloud infrastructures, such as Azure VMware Solution (AVS) and other VMware-powered clouds. It offers features like secure network extension, automated workload migration, and seamless disaster recovery, ensuring minimal downtime and disruption during the migration process. HCX simplifies hybrid cloud operations by providing a unified platform for workload mobility, application deployment, and ongoing management, enabling organizations to leverage the benefits of both private and public cloud environments with ease.

2.4 Hardware components

The hardware components used in this design are listed below:

- Lenovo ThinkAgile VX3331
 - CPU
 - 2x Intel Xeon Gold 6326 16C 185W 2.9GHz Processor
 - Compute Optimized: 2x Intel Xeon Gold 6342 24C 230W 2.8GHz Processor
 - RAM
 - 12x ThinkSystem 32GB TruDDR4 3200 MHz RDIMM
 - Compute Optimized: 12x ThinkSystem 64GB TruDDR4 3200 MHz RDIMM
 - Boot
 - 2x ThinkSystem M.2 5400 PRO 480GB Read Intensive SATA 6Gb NHS SSD
 - vSAN
 - Cache Tier: 2x ThinkSystem 2.5" U.2 P5620 1.6TB Mixed Use NVMe PCIe 4.0 x4 HS SSD

- Capacity Tier: 6x ThinkSystem 2.5" S4520 1.92TB Read Intensive SATA 6Gb HS SSD
- 2x Lenovo ThinkSystem DM5000H
 - 2x Lenovo ThinkSystem 5.8TB (6x 960GB, 2.5", Non-SED, SSD) Drive Pack for DM5000H - Premium Bundle - ONTAP: Unified

2.4.1 Lenovo ThinkAgile VX Series

Lenovo ThinkAgile VX Series is a turnkey hyperconverged infrastructure (HCI) solution, tested and validated for VMware vSAN compliance. Powered by the most reliable and secure server platforms and VMware's virtualization software ecosystem, it features next generation technology to future-proof infrastructures and enable deep integration across the stack. It helps organizations keep up with workload capacity and performance needs to drive revenue growth and efficiencies across the infrastructure.

ThinkAgile VX provides virtualized compute and storage capabilities to run a variety of workloads and applications powered by industry-leading VMware software such as VMware vSAN, VMware vSphere and VMware Cloud Foundation.

The ThinkAgile VX Integrated System comes preinstalled with VMware software. The deployer tool provides for faster day 0 and day 1 operations. XClarity Integrator acting as the Hardware Support manager (HSM) for the vSphere Life Cycle Manager (vLCM), handles lifecycle management of both software and firmware updates via a single pane of glass that fully integrates VMware tools. ThinkAgile VX Integrated Systems are bundled with Premier Support providing a single-point-of-contact for quick 24/7 hardware and software support, problem reporting and resolution.

The VX Certified Node is pre-configured with the necessary hardware components, including compute, storage, and networking resources, to simplify deployment and accelerate time to value when deploying new clusters or expanding with additional nodes.

Customers can also leverage Lenovo TruScale Hybrid Cloud with VMware, an infrastructure as a service (IaaS) offering that gives enterprises access to the resources they need, when they need them. It provides the flexibility of a scalable pay as you go model that frees up capital for other business initiatives, and comprehensive management and support to accelerate their hybrid multi cloud transformation.

The server used for this design is the Lenovo ThinkAgile VX3331, a 1U dual socket Intel Xeon system with the potential of up to 40 cores per CPU (80 threads) and 32 DIMM slots supporting a total of 4TB of RAM. It is a highly versatile & customizable system that can be tweaked to meet the needs of any workload. While the VX3331 is used in this reference architecture, customers can choose from multiple ThinkAgile solutions and customize the specifications to match their needs. Customers may also choose different servers for different VI workload domains or additional clusters deployed through VCF for specific workload types.

All three configurations in this design consist of 11.5TB of raw vSAN storage per-node. VMware's vSAN Storage Policies will determine storage consumed, as well as govern performance and level of data protection.

2.4.2 Lenovo ThinkSystem DM5000H

The ability to scale out storage decoupled from compute is accomplished using Lenovo's ThinkSystem DM5000H Unified Hybrid Storage Array. Lenovo's ThinkSystem DM5000H Unified Hybrid Storage Array is a high-performance and scalable storage solution designed to meet the diverse needs of modern data centers. This storage array combines the benefits of solid-state drives (SSDs) and hard disk drives (HDDs) to deliver optimal performance and cost-efficiency. With its unified architecture, the DM5000H supports both block and file storage protocols, providing flexibility for a wide range of workloads. It offers advanced features such as data deduplication, compression, and automated tiering, optimizing storage efficiency and reducing costs. The DM5000H ensures high availability and data protection through features like snapshot, replication, and integrated data management. With its easy-to-use management interface, organizations can effectively monitor, configure, and provision storage resources. Overall, the ThinkSystem DM5000H Unified Hybrid Storage Array delivers reliable, scalable, and efficient storage for modern data centers, enabling organizations to meet their growing storage demands while maximizing performance and cost-effectiveness.

Each 2U chassis can hold up to 24 Small Form Factor (SFF) disks, and a single ThinkSystem DM5000H Storage Array can scale up to 144 drives with the attachment of Lenovo ThinkSystem Expansion Enclosures, scaling up to 1.96PB of raw storage capacity.

3 Implementation

3.1 On Premises

The following (Figure 6) is a logical cabling diagram of a consolidated architecture with two distinct network paths, cabled for HA. Each server in the cluster should be cabled to ToR-A and ToR-B consistently. Example, fabric A all use the same server port on each server, fabric B using the other port.

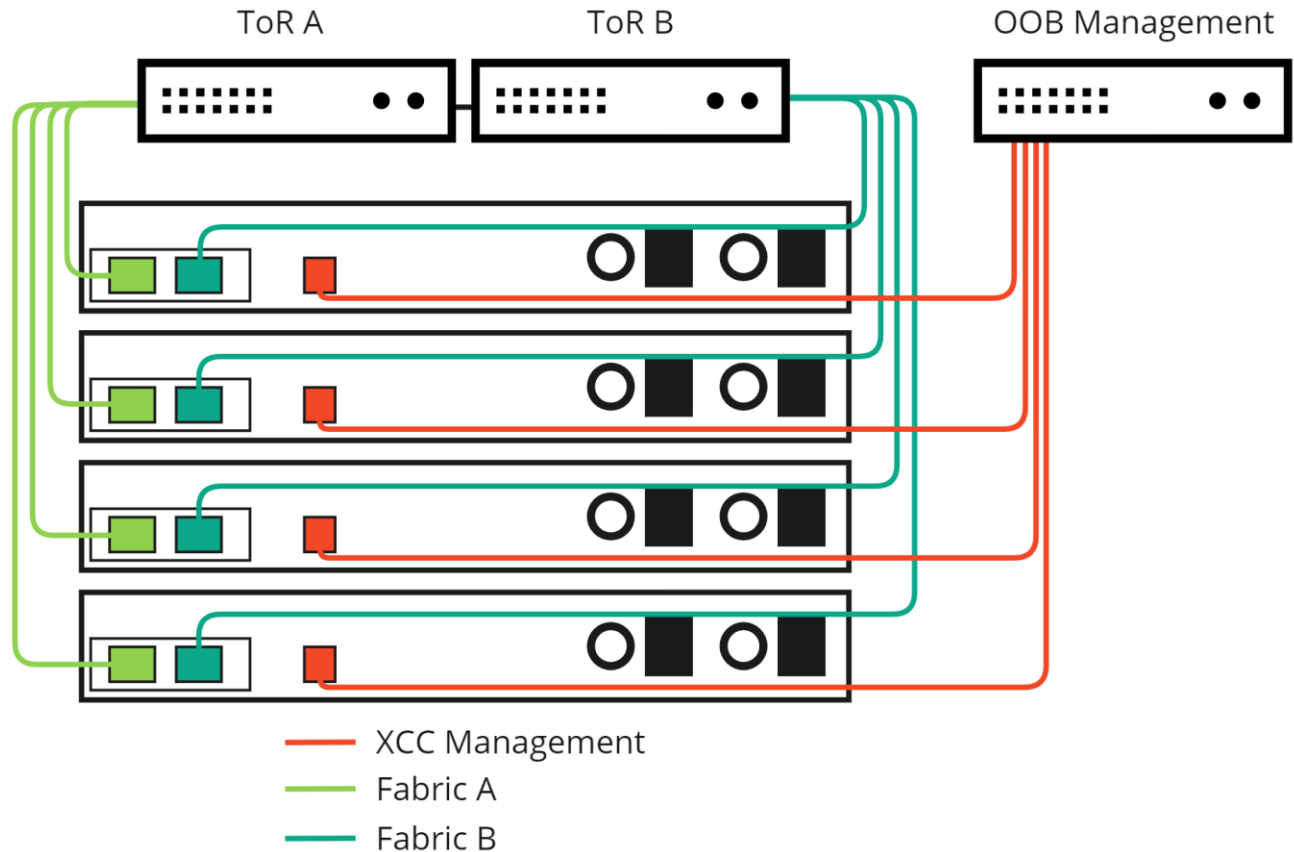


Figure 6: Logical cabling diagram for Lenovo ThinkAgile VX3331 servers

3.1.1 Lenovo XClarity Administrator

This reference architecture optimizes the deployment of ESXi images across multiple physical servers using Lenovo XClarity Administrator. XClarity Administrator streamlines the process by enabling the import of a custom ESXi image with an unattend file tailored to specific requirements and configurations to prepare the host for VCF. This custom image includes Lenovo-specific drivers and other components necessary to allow ESXi to properly discover and communicate with all hardware components in the server. With XClarity Administrator's firmware profile capabilities, customers can create standardized configurations for the servers, ensuring consistency and stability throughout the deployment process. These firmware profiles can be applied to each server, ensuring that they are running the correct firmware versions and settings for the ESXi image to fully align with the VMware vSAN HCL. By utilizing Lenovo XClarity Administrator's capabilities, customers can achieve efficient and reliable deployment of ESXi images, minimizing manual intervention and reducing

the risk of errors, thereby enhancing the overall performance and management of physical server infrastructure, while also preparing to deploy VCF. As depicted in *Figure 7*, the vSphere administrator will interact with the Lenovo XClarity Administrator console to automate the deployment of custom ESXi image, as well as orchestrate firmware updates.

Note: Firmware management should only be carried out through XClarity Administrator prior to deployment of the SDDC.

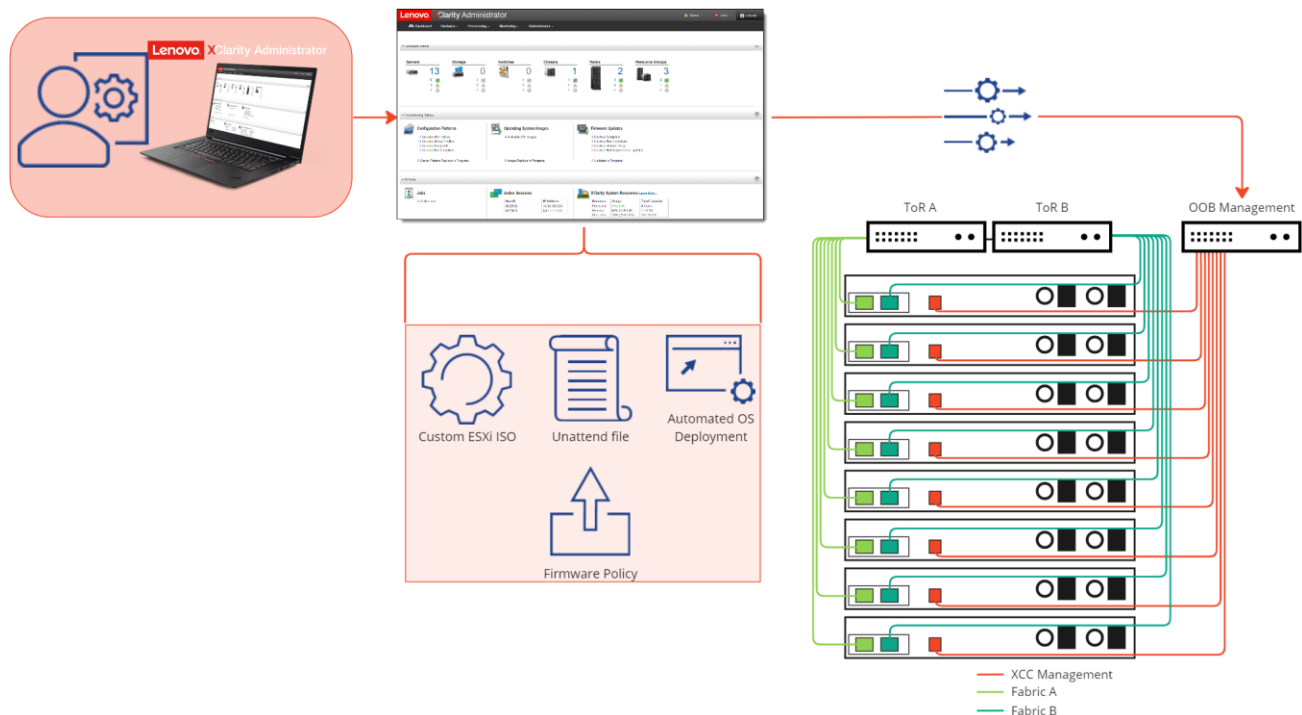


Figure 7: Lenovo XClarity Administrator communicates to the XClarity Controller in each server to automatically deploy the OS

3.1.2 VMware Cloud Builder

VMware Cloud Builder utilizes the specifications provided in the Deployment Parameter Workbook to orchestrate the deployment of a highly prescriptive SDDC. By parsing and interpreting the parameters, Cloud Builder automatically deploys and configures the necessary VMware products and components, ensuring a standardized and consistent SDDC setup. This streamlined process minimizes complexity and potential errors, enabling organizations to establish a robust and optimized SDDC environment quickly and confidently in an automated workflow. Once Cloud Builder has successfully deployed the SDDC, it is no longer used and all operations are carried out using either VMware SDDC Manager or Lenovo XClarity Integrator for VMware vCenter.

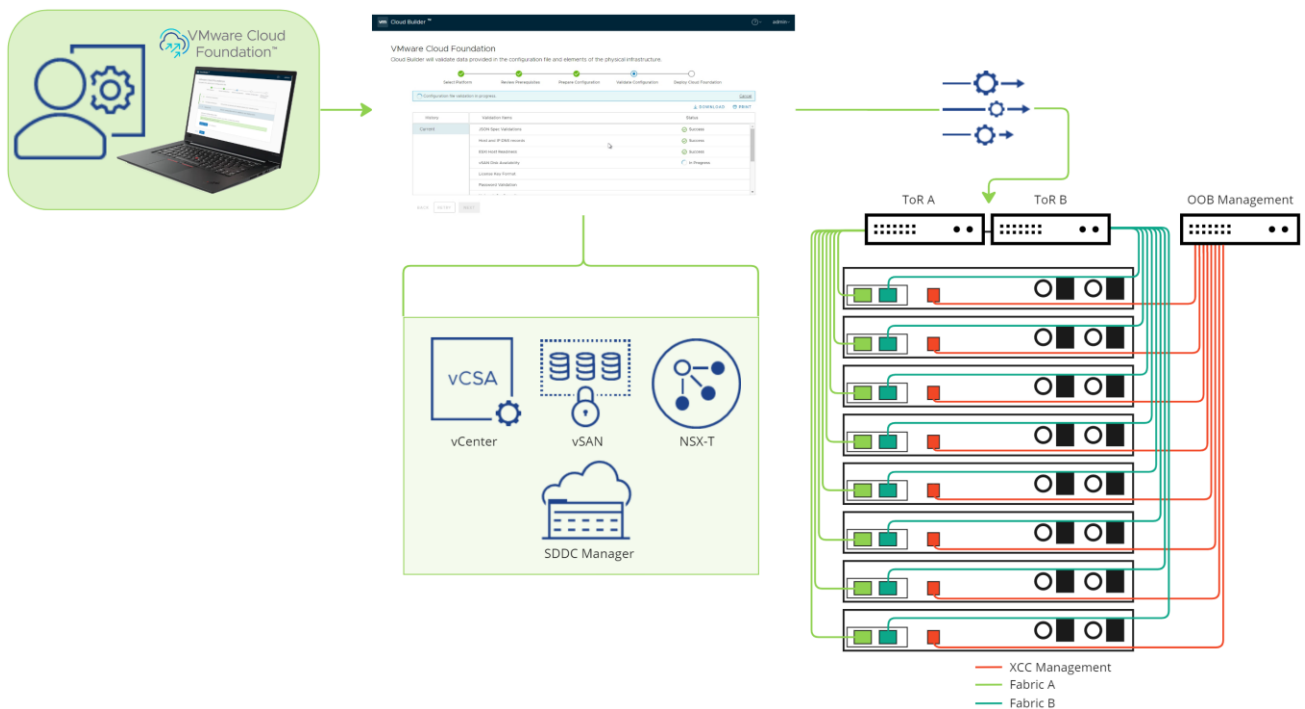


Figure 8: VMware Cloud Builder validates the parameters supplied prior to the automated deployment of the SDDC

VMware Cloud Builder will create the vSphere Distributed Switch (VDS) with all the necessary Distributed Port Groups, along with the associated VLAN IDs provided in the Deployment Parameter Workbook. Each ESXi node will have these distributed port groups on the VDS for the various vmkernel (VMK) ports created during the deployment phase. The following (*Figure 9*) is a logical diagram of how these are connected internally, as well as how the NSX Edge VM is connected:

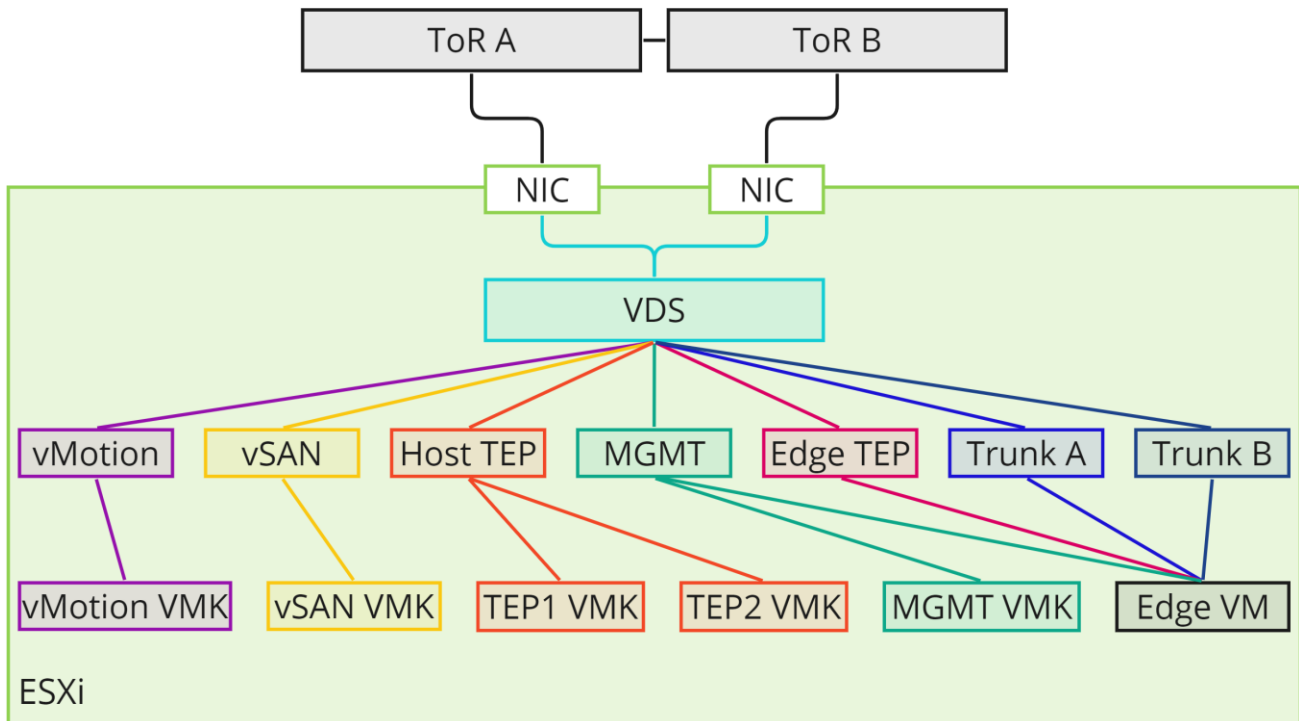


Figure 9: Each ESXi host in an SDDC cluster will have multiple vmkernel ports connected through specific port groups

Additional port groups will be created to support VM workloads. The broader view of the environment consists of multiple networks with VMs and vmkernel ports connected to them. The following (*Figure 10*) is a logical view of how each VM is connected, as well as the vmkernel ports. For VMs connected to VLAN-backed NSX Segments, or Distributed Port Groups, the traffic routes at the ToR. For VMs connected to overlay NSX Segments, the routing happens either in the ESXi kernel via distributed routing for inter-NSX Segment communications (east-west routing), or in the NSX Edge VM when communicating outside of the environment (north-south routing).

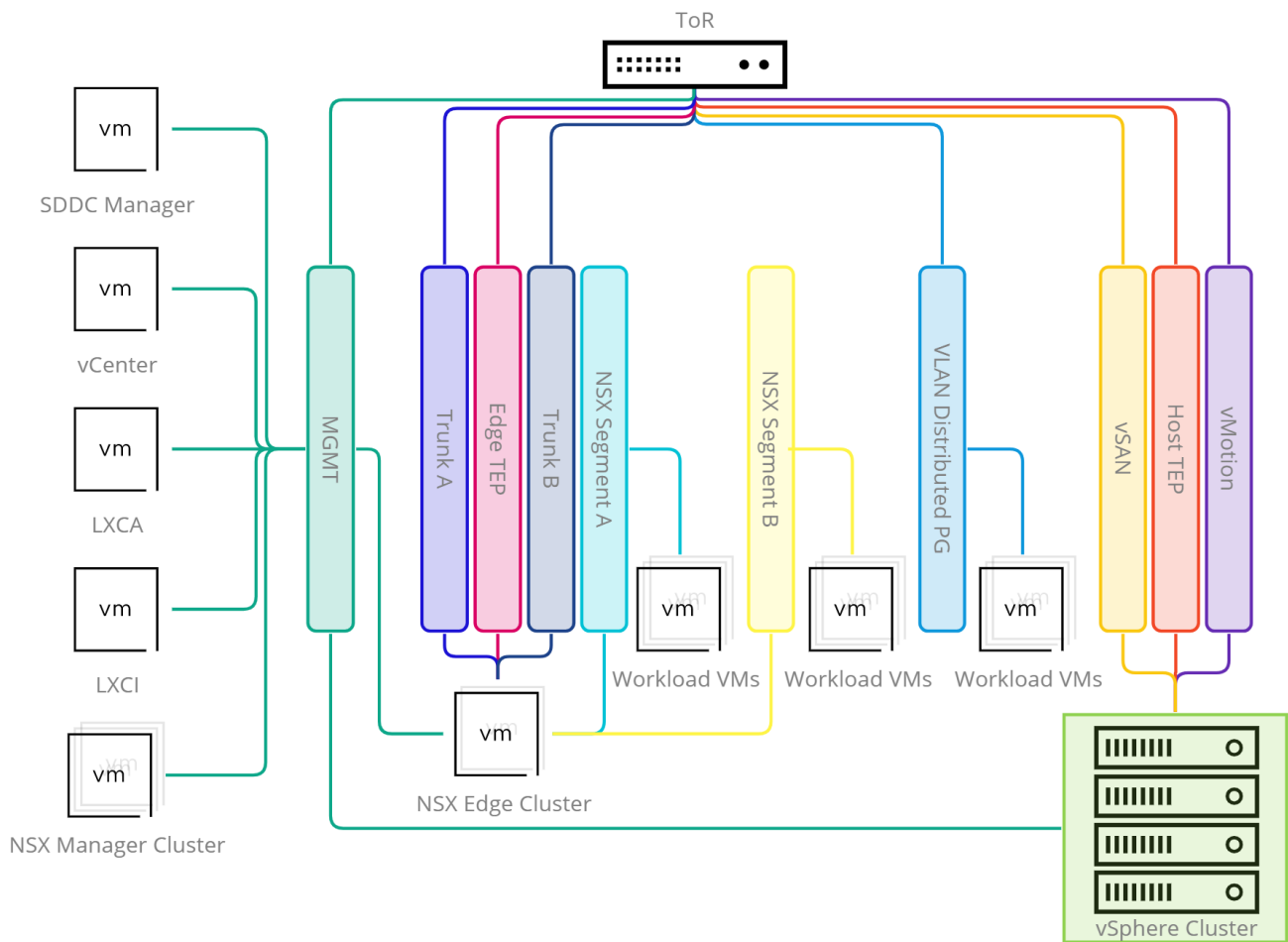


Figure 10: Logical representation of how all components in the SDDC are connected

3.1.3 Lenovo XClarity Integrator for VMware vCenter

Lenovo XClarity Integrator for VMware vCenter (LXCI) seamlessly integrates essential hardware maintenance functionalities, including firmware updates and rolling reboots, directly into the VMware vCenter interface. This integration brings all these critical capabilities right within vCenter, eliminating the need for separate tools or interfaces. Moreover, the solution offers a comprehensive topology view, enabling administrators to visualize open disk slots easily. This visual representation facilitates the efficient addition of vSAN storage whenever necessary, enhancing the overall management and scalability of the virtualized environment through the familiar vCenter platform. The Hardware Topology view provides multiple actions, including interacting with the LED (on/blink), as well as launching the BMC/XCC interface or remote console. Topology view also allows you to visualize drives assigned to the cache and capacity tiers, assigned diskgroups, health status of the drives and associate drives to the HBA and backplane connections making the physical to logical mapping easy for maintenance.

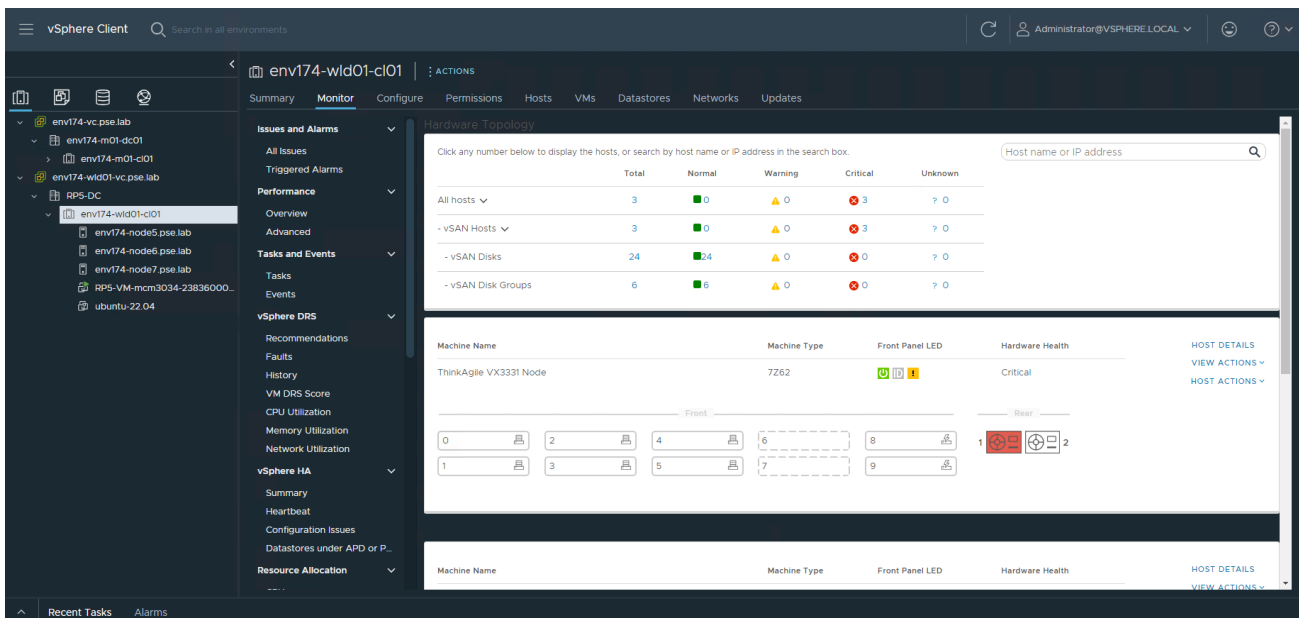


Figure 11: Lenovo Hardware Topology view from the Cluster level

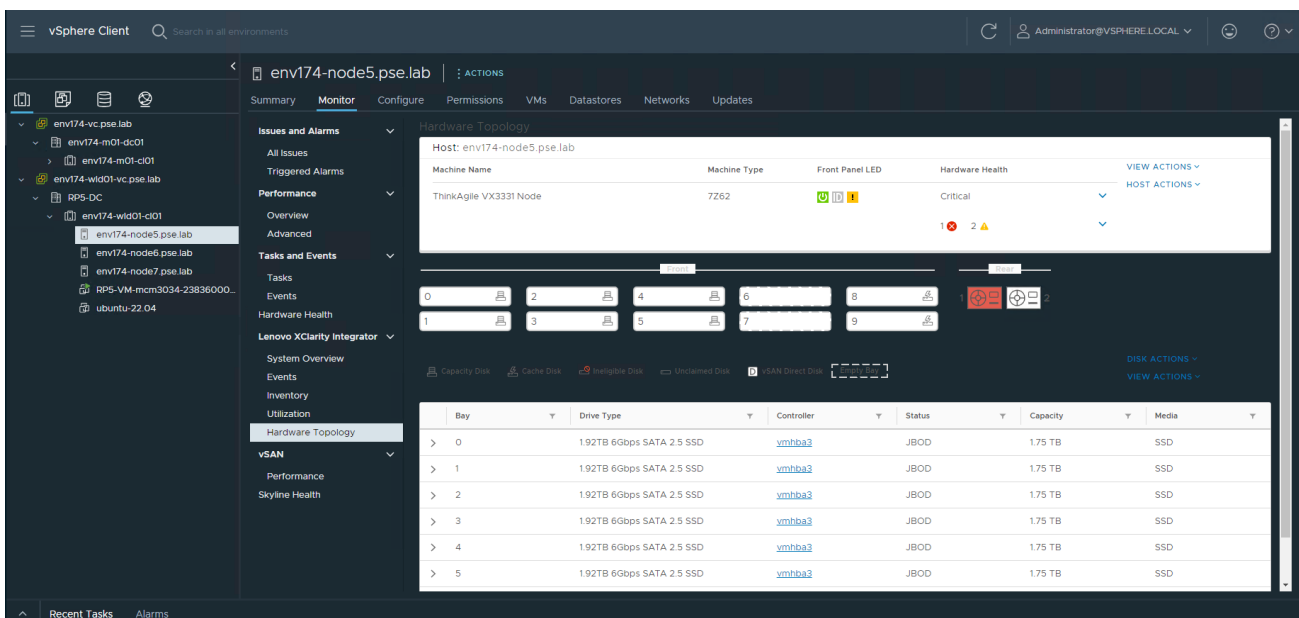


Figure 12: Lenovo Hardware Topology view from the Host level

NOTE: The host level exposes additional capabilities added by LXCI

3.1.4 Lenovo Firmware Management with LXCI

Lenovo XClarity Integrator for VMware vCenter adds cluster-level rolling updates and reboots. This vCenter integration allows non-disruptive firmware management through the integration with Lenovo XClarity Administrator by exposing firmware policies created in LXCA. This enables vSphere administrators to easily apply the policies and ensure the firmware running in their environment matches the supported firmware listed on the VMware HCL. The Rolling Reboot function also gives administrators one more tool that allows them to

effortlessly reboot an entire vSAN cluster, or schedule the reboot at a time that best suites the environment. LXCI can also be used without LXCA and instead used with VMware vSphere Lifecycle Management (vLCM). This allows a user to create their Cluster Image Definition using the Lenovo Addon for customized drivers, Repository Pack for Lenovo and vSAN validated firmware and choose from a number of available ESXi versions. The ESXi versions must align with the VCF supported versions, and then can be imported into SDDC Manager for Lifecycle Management Image Management.

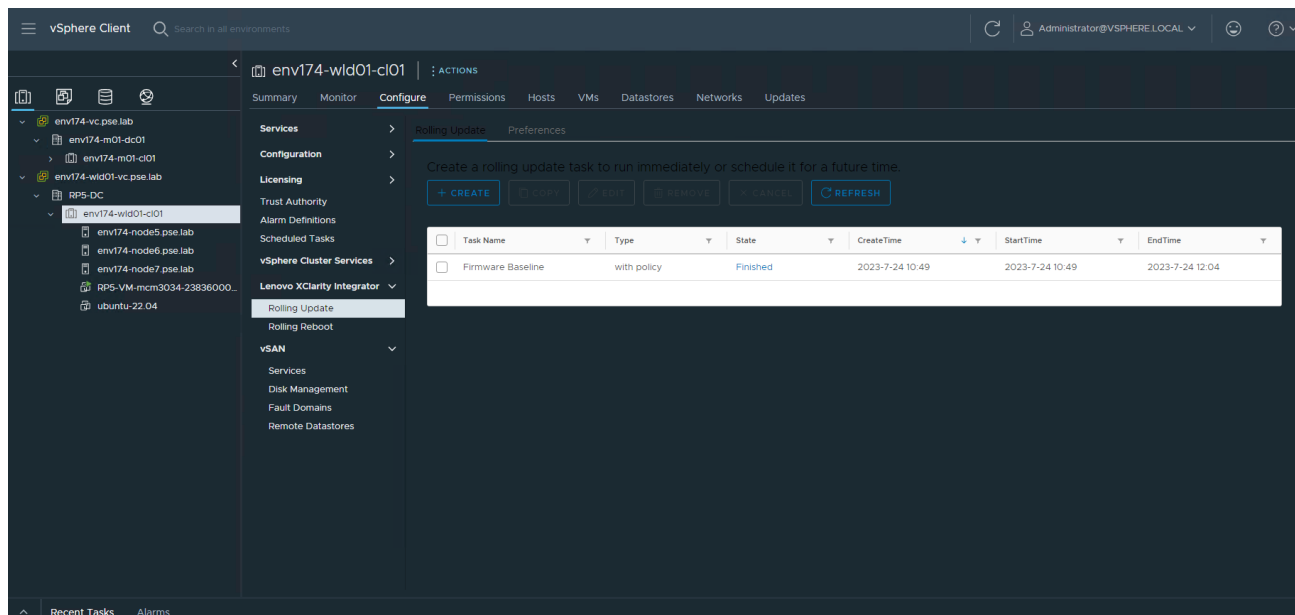


Figure 13: Lenovo XClarity Integrator brings in firmware policies created in XClarity Administrator

3.2 Hybrid Cloud

As organizations continue to embrace hybrid cloud architectures to strike a balance between the benefits of on-premises infrastructure and public cloud services, a reliable, scalable, and secure solution becomes essential. This reference architecture explores the utilization of Microsoft Azure VMware Solution (AVS) to create a seamless and efficient hybrid cloud environment. For more information regarding deploying AVS, please see this article: <https://learn.microsoft.com/en-us/azure/azure-vmware/deploy-azure-vmware-solution>

AVS enables customers to extend their existing VMware-based environments to Azure, allowing seamless workload migration without the need for re-architecting applications or retraining staff. It is natively integrated with Azure services, offering access to a wide range of Azure offerings, including AI/ML, data analytics, IoT, and more, making it easier to build hybrid cloud solutions that best suit specific business needs. Leveraging Azure's capabilities, AVS enables automated deployment, scaling, and management of VMware-based workloads, optimizing resource utilization and minimizing manual intervention. By replicating on-premises VMware workloads to Azure, AVS provides organizations with a reliable disaster recovery solution, ensuring business continuity in case of unexpected outages or disasters.

This reference architecture utilizes Azure ExpressRoute for connectivity between on-premises environments and AVS (Figure 14), which offers several advantages, such as dedicated private connections, predictable performance, reduced latency, and enhanced security. This is especially beneficial for data-intensive

workloads or compliance-sensitive applications. For more information on setting up Microsoft Azure ExpressRoute, please see this article: <https://vmc.techzone.vmware.com/resource/connecting-equinix-expressroute-microsoft-azure-vmware-solution>

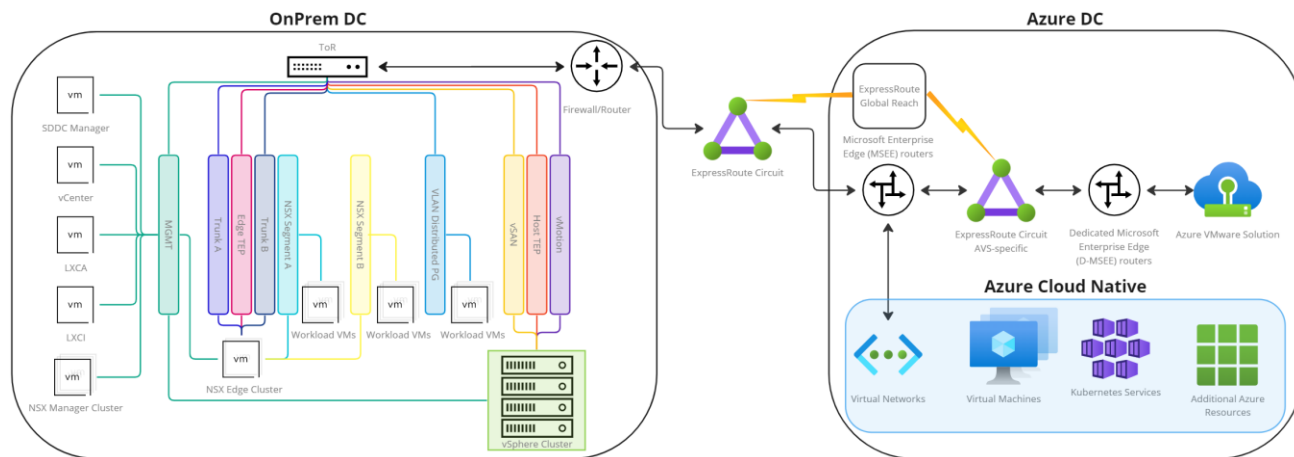


Figure 14: Logical representation of a hybrid cloud connected through Azure ExpressRoute

There are a number of connectivity options to pair the on-premises environment with Azure, including SD-WAN solutions like VMware VeloCloud. VeloCloud can be an alternative for connectivity, providing a more flexible and cost-effective option for certain use cases. SD-WAN allows organizations to optimize traffic across multiple network links and prioritize critical workloads based on application requirements.

Customers have the flexibility to explore other connectivity options to tailor the solution to their specific needs. It is essential for organizations to assess their requirements and choose the best connectivity solution that aligns with their business objectives, ensuring a successful hybrid cloud deployment.

Once a connection between the sites is in place, VMs in the on-premises environment, regardless of whether they are connected to NSX segments or distributed port groups, will have the capability to route through ExpressRoute. This connectivity will enable them to communicate with other resources in Microsoft Azure, including VMs hosted in AVS, as well as any other native Azure services.

VMware HCX simplifies and accelerates workload migration between on-premises data centers and AVS in Azure (Figure 15). This includes live vMotion, bulk migration, and scheduled migrations with minimal downtime and no application refactoring. HCX's WAN optimization capabilities ensure efficient data transfer and network utilization, reducing latency and ensuring a smooth migration experience. It also facilitates bidirectional workload mobility, enabling businesses to easily move workloads between multiple on-premises data centers and Azure regions.

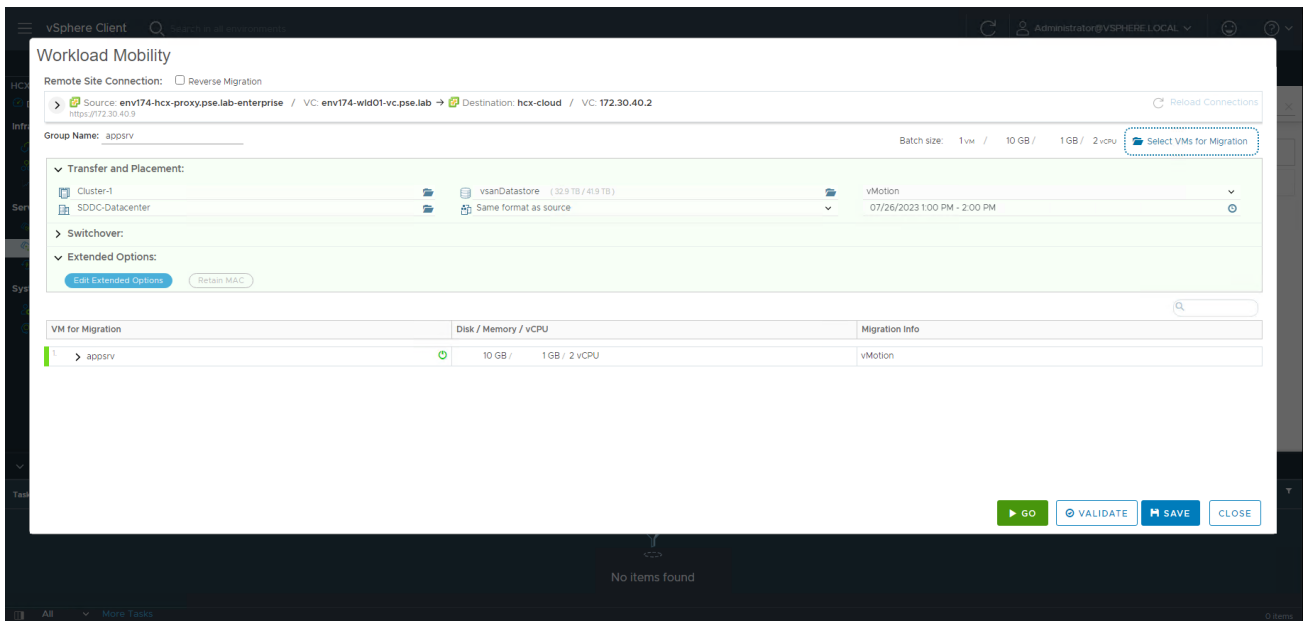


Figure 15: VMware HCX Workload Mobility provides the option to schedule workload migrations

In addition to workload migration, VMware HCX plays a crucial role in enabling efficient disaster recovery management (Figure 16). In the event of a disaster or unexpected outage, HCX facilitates rapid failover and failback processes, minimizing downtime and ensuring business continuity. With its robust network extension and optimized data replication, HCX simplifies disaster recovery operations by also providing the ability to test the recovery operations.

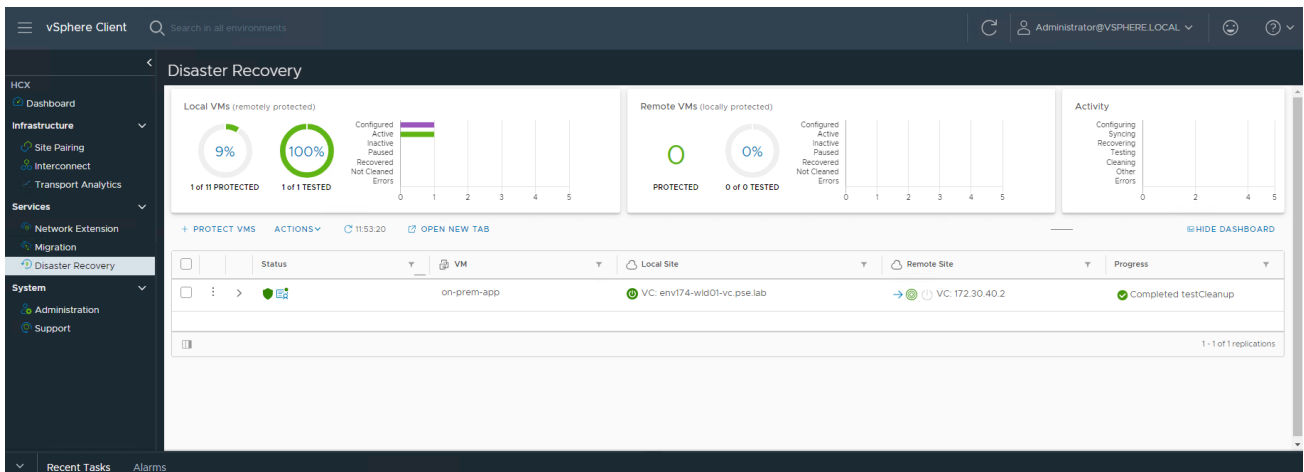


Figure 16: VMware HCX Disaster Recovery provides the ability to define RPO and snapshots, as well as test failover

3.3 Managing a hybrid cloud



Figure 17: VMware Aria Operations home page with the new Sustainability widget showing Greenscore, Power Consumption, Carbon Footprint, and Environment Impact.

3.3.1 VMware Aria

Managing a hybrid cloud environment efficiently requires robust solutions that can seamlessly integrate various components. VMware Aria Operations and VMware Aria Automation emerge as highly suitable choices, offering a range of advantages and integration capabilities. VMware Aria Operations affords organizations invaluable insights into the performance, health, and capacity of their hybrid cloud infrastructure, facilitating proactive issue identification, resource optimization, and effective problem resolution. Furthermore, the Lenovo XClarity management pack for VMware Aria Operations extends its capabilities through direct integration with Lenovo hardware via Lenovo XClarity Administrator (Figure 18).

This integration empowers users with granular visibility and management of Lenovo-powered hardware components, thereby enhancing operational efficiency and simplifying maintenance tasks.

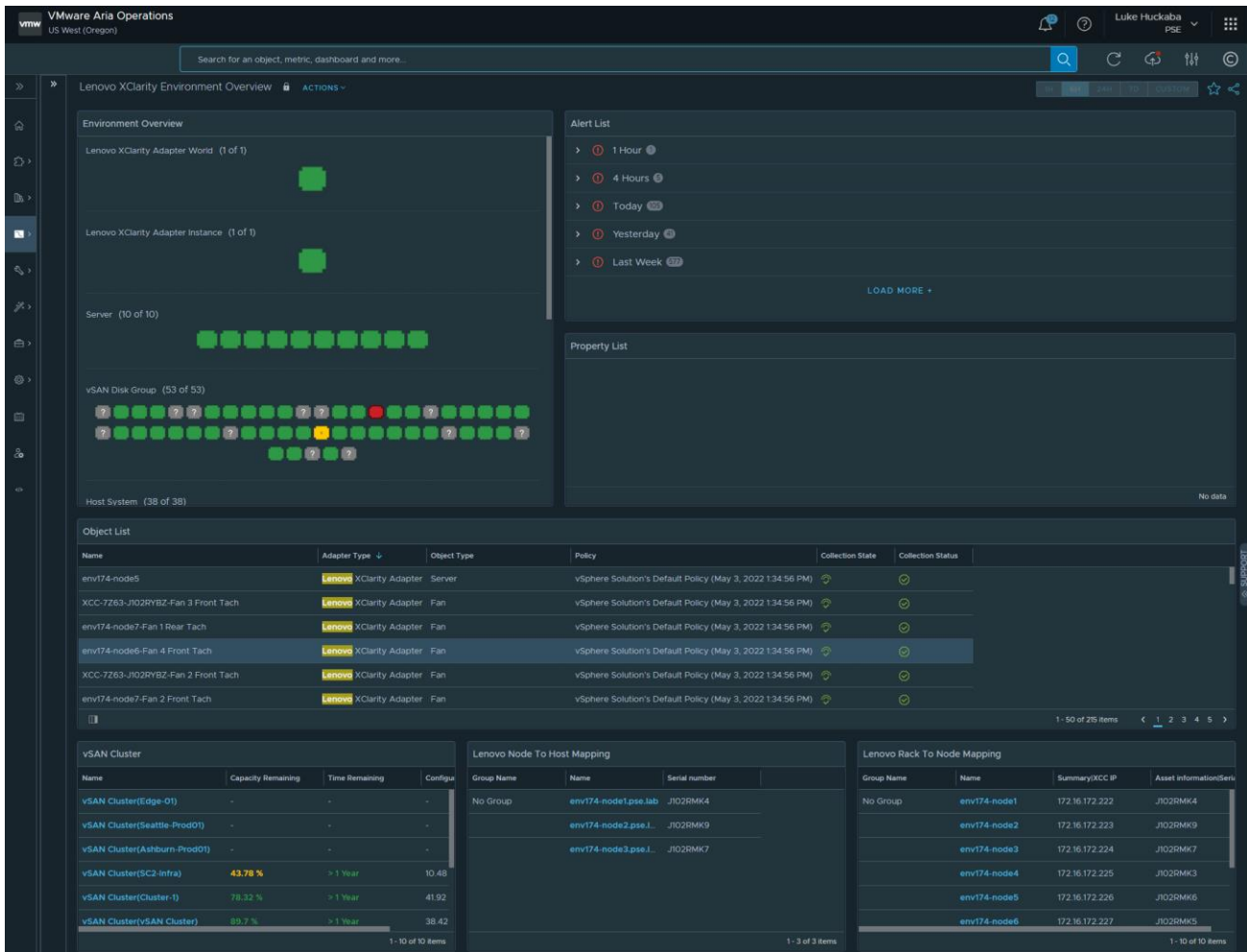


Figure 18: This is one of many new dashboards included in the Lenovo XClarity management packs for VMware Aria Operations

VMware Aria Automation expedites the provisioning and management of workloads across the hybrid cloud, providing a streamlined and user-centric approach. Users can effortlessly request and access resources while adhering to governance and compliance policies. Administrators are able to provide a self-service portal for VMware Aria Automation to users across different business units and programmatically & prescriptively for the accelerated deployment of resources (Figure 19 & Figure 20). This portal expedites the deployment of resources, ensuring a streamlined and efficient process for users to request and access the required resources. The amalgamation of VMware Aria Automation and the Lenovo hardware integration facilitated by The Lenovo management pack for VMware Aria Operations results in a harmonious and orchestrated hybrid cloud environment. This cohesion enables seamless migration of applications and workloads between on-premises and cloud-based resources, fostering scalability, agility, and operational fluidity. VMware's cloud solutions, combined with the integration of Lenovo infrastructure, emerge as a wise option for enterprises seeking to optimize their hybrid cloud deployments.

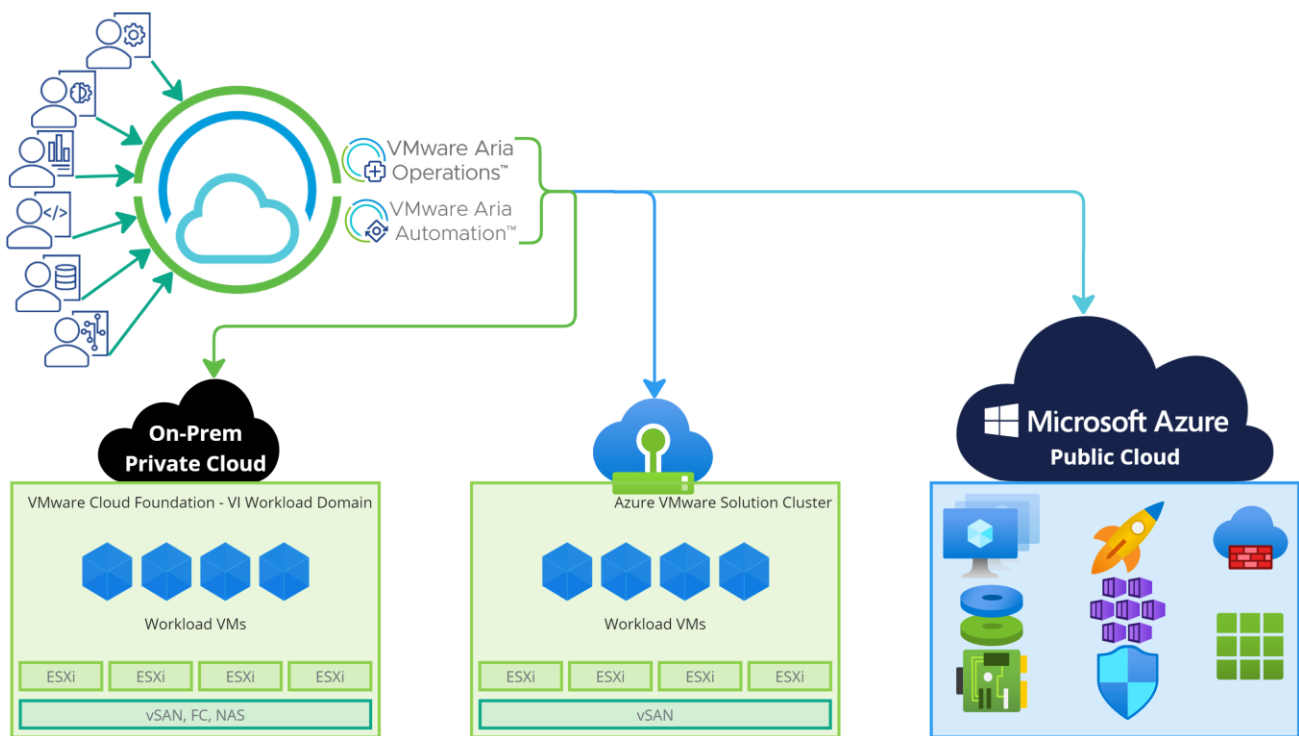


Figure 19: VMware Aria is the on-ramp to allow self-service deployments and monitoring of resources in a multi-cloud environment

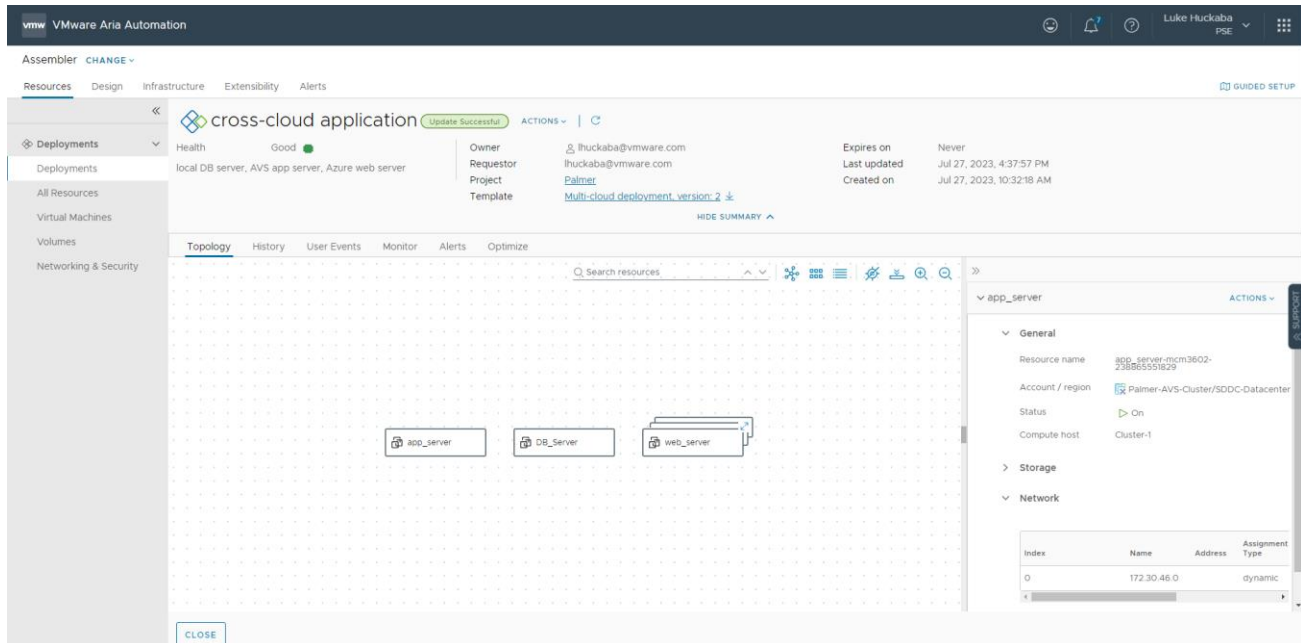


Figure 20: A single deployment in VMware Aria Automation deploys virtual servers across on-premises, AVS, and Azure Cloud.

Incorporating the SaaS version of VMware Aria offers several advantages that significantly reduce overhead and streamline operations for vSphere administrators. One of the key benefits is the reduction in manual administrative tasks related to updates and enhancements. With the SaaS version of VMware Aria, updates, including feature enhancements and bug fixes, are automatically and regularly rolled out by VMware. As a result, vSphere admins no longer need to allocate time and effort to apply updates, ensuring that the environment remains up-to-date with the latest improvements without any additional burden on their part.

Furthermore, the SaaS version of VMware Aria provides a unified and centralized management platform, acting as a single pane of glass for visibility and control over the entire hybrid cloud environment. This comprehensive view enables administrators to monitor and manage various components, applications, and workloads across both on-premises and cloud-based resources from a centralized dashboard. This centralized approach simplifies the management process, streamlines troubleshooting, and enhances overall efficiency, as vSphere admins can quickly access critical information and perform necessary tasks without switching between multiple interfaces.

Deploying VMware Aria SaaS involves simply deploying a cloud proxy each for VMware Aria Automation and VMware Aria Operations (Figure 21). These cloud proxies facilitate the communication, orchestration, and data collection across many aspects of the on-premises environment.

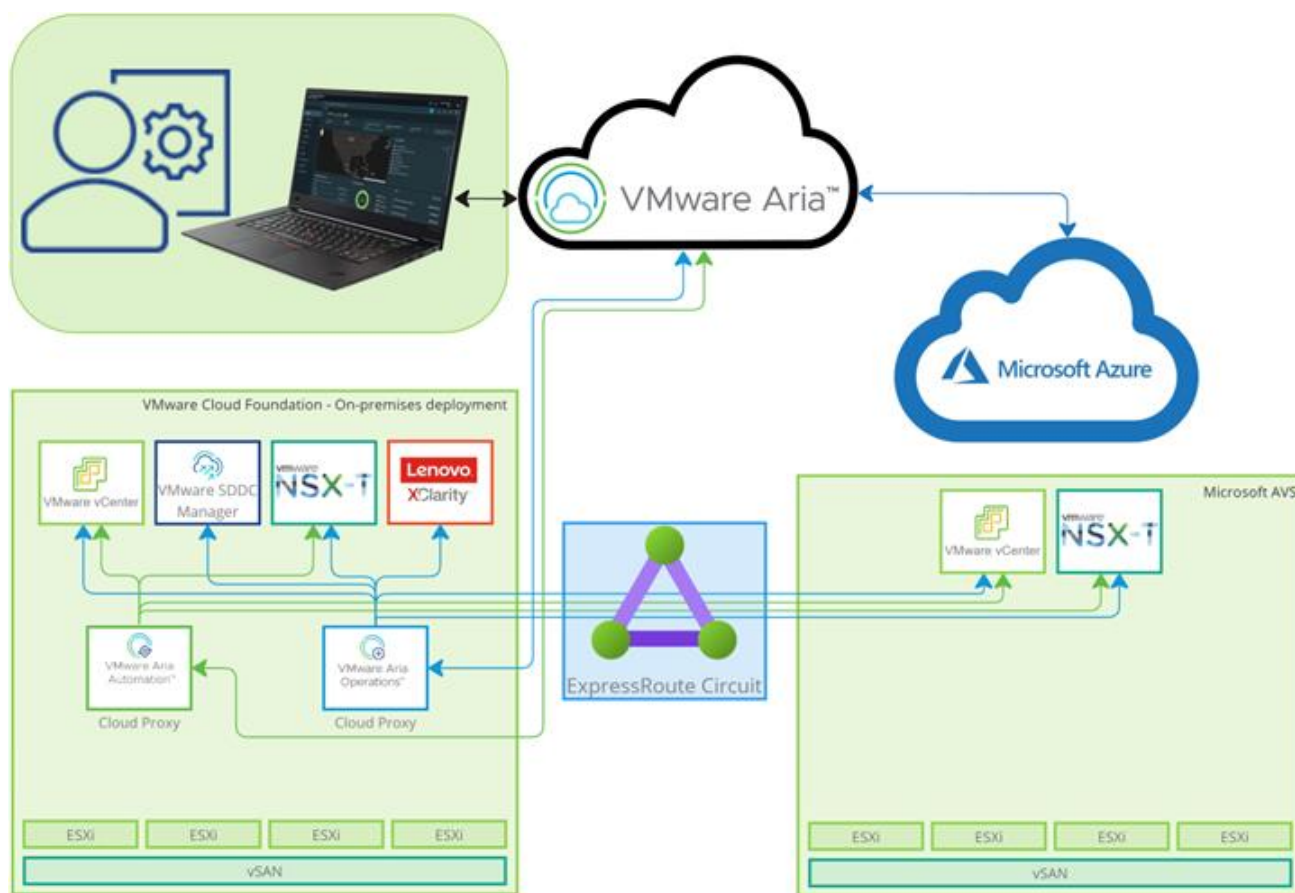


Figure 21: VMware Aria Automation and VMware Aria Operations cloud proxies provide direct communication to the on-premises tools

4 Use Cases

Hybrid cloud solutions offer various benefits and use cases that cater to diverse business requirements. Here are a few examples:

4.1 Disaster Recovery and Business Continuity

One of the primary use cases for a hybrid cloud is to implement a robust disaster recovery strategy. By replicating critical workloads and data between on-premises infrastructure and the cloud, organizations can ensure business continuity in the event of a disaster, such as hardware failure, natural calamities, or cyberattacks. The hybrid cloud provides an ideal platform for cost-effective and reliable data replication and failover solutions.

4.2 Data Backup and Archiving

Hybrid cloud solutions offer an excellent way to manage data backup and long-term archiving. Organizations can store critical data on-premises for fast access and use the cloud for cost-effective, scalable, and reliable data archival. This approach ensures data redundancy, compliance adherence, and efficient management of large datasets.

Veeam is a comprehensive data backup and archive tool designed to work with VMware workloads, offering robust disaster recovery capabilities. With its Microsoft Azure plugin, Veeam seamlessly integrates with Azure cloud services, enabling users to efficiently manage and protect their virtualized environments across on-premises and cloud infrastructures. This combination of features ensures reliable data protection, simplified recovery processes, and enhanced business continuity for organizations utilizing VMware and Microsoft Azure. For additional information regarding the Microsoft Azure Plug-In for Veeam Backup & Replication, please visit https://helpcenter.veeam.com/docs/vbazure/vbr_integration/overview.html

Lenovo recently introduced a reference architecture enhancing data protection and management capabilities. By integrating Veeam backup solutions with the robust ThinkSystems DM storage and the ThinkAgile VX series hyperconverged solution, users can now benefit from a seamless and optimized backup experience. This collaboration ensures that data integrity and availability are maximized, providing enterprises with a powerful solution to safeguard their critical information effectively. For additional information, see the reference architecture here: <https://lenovopress.lenovo.com/lp1769.pdf>

4.3 Scalability and Bursting

Hybrid cloud environments allow businesses to address fluctuating demands and varying workloads effectively. When on-premises resources reach their capacity, organizations can "burst" into the public cloud, leveraging its virtually limitless scalability to handle peak loads. This elasticity ensures efficient resource utilization, cost optimization, and improved performance during peak periods.

4.4 DevOps and Testing

The hybrid cloud is well-suited for DevOps practices and software development testing. Developers can deploy and test applications in the cloud without interfering with the production environment. This separation of development and production environments improves collaboration, accelerates development cycles, and minimizes risks associated with changes.

4.5 Geographic Reach and Data Sovereignty

Hybrid cloud solutions provide the ability to deploy applications and services in geographically dispersed data centers, complying with data sovereignty regulations and improving latency for regional users. This use case is particularly relevant for global organizations seeking to deliver low-latency experiences and adhere to data residency requirements.

Resources

For more information, see these resources:

- Deployment Guide: Hybrid Cloud Solution with VMware Cloud Foundation on Lenovo ThinkAgile VX with Microsoft Azure VMware Service – <https://lenovopress.lenovo.com/lp1795>
- Lenovo XClarity Administrator - <https://lenovopress.lenovo.com/tips1200-lenovo-xclarity-administrator>
- Lenovo XClarity Integrator for VMware vCenter - <https://support.lenovo.com/us/en/solutions/ht115212-lenovo-xclarity-integrator-for-vmware-vcenter>
- Lenovo ThinkAgile VX Series - <https://www.lenovo.com/us/en/servers-storage/sdi/thinkagile-vx-series/>
- Lenovo ThinkSystem DM Series Unified Storage Arrays - <https://lenovopress.lenovo.com/lp0941-lenovo-thinksystem-dm-series-unified-storage-arrays>
- VMware Cloud Foundation - <https://www.vmware.com/products/cloud-foundation.htm>
- VMware Cloud Builder - <https://docs.vmware.com/en/VMware-Cloud-Foundation/4.5/vcf-deploy/GUID-78EEF782-CF21-4228-97E0-37B8D2165B81.html>
- VMware SDDC Manager - <https://docs.vmware.com/en/VMware-Cloud-Foundation/4.5/vcf-admin/GUID-D143F07A-B3FA-4A14-8D03-BFD2C1810D2E.html>
- VMware vSphere - <https://www.vmware.com/products/vsphere.html>
- VMware vSAN - <https://www.vmware.com/products/vsan.html>
- VMware NSX - <https://www.vmware.com/products/nsx.html>
- VMware Aria - <https://www.vmware.com/products/aria.html>
- VMware HCX - <https://www.vmware.com/products/hcx.html>

Acknowledgements

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