

# VMware Cloud Foundation on Dell EMC VxRail

Accelerating the Journey to VMware Software-Defined Data Center and Hybrid Cloud with the Dell Technologies Cloud Platform.

## Abstract

VMware Cloud Foundation™ on Dell EMC™ VxRail™, the Dell Technologies Cloud Platform, delivers a simple and direct path to the hybrid cloud and Kubernetes at cloud scale with one, complete, automated platform. By deploying VMware Cloud Foundation on VxRail customers get full stack integration with both the HCI infrastructure layer and VMware cloud software stack. Automated lifecycle management is provided as a single, complete, turnkey hybrid cloud experience greatly reducing risk and increasing IT operational efficiency. VxRail HCI system software's unique integration between SDDC Manager and VxRail Manager combines operational transparency with automation, support, and serviceability capabilities not found when deploying VMware Cloud Foundation on any other infrastructure.

September 2020

## Revisions

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July 19, 2019	Initial version.
October 30, 2019	Updated to cover VMware Cloud Foundation on VxRail version 3.8.1 feature set.
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## Executive summary

The Introduction section summarizes the business IT challenges and trends that lead to the VMware SDDC and VMware Cloud Foundation solutions, further detailed in *Appendices B, C, and D*.

VMware Cloud Foundation on Dell EMC VxRail, the Dell Technologies Cloud Platform, provides the simplest path to the hybrid cloud through a fully integrated platform that leverages native VxRail hardware and software capabilities as well as unique VxRail integrations (such as vCenter plugin and full stack integration) to deliver a turnkey user experience with full stack integration. Full stack integration enables customers to experience both the HCI infrastructure layer and cloud software stack in one, complete, automated lifecycle, turnkey experience.

VMware Cloud Foundation on Dell EMC VxRail provides a consistent hybrid cloud experience unifying customer public and private cloud platforms under a common operating model and management framework. Customers can operate both their public and private platforms using one set of tools and processes with a single management view and provisioning experience across both platforms. Customers are able to build, run, and manage a broad set of workloads from traditional and legacy applications to virtual desktops, as well as next generation workloads from artificial intelligence and machine learning to cloud native and container-based workloads. VMware Cloud Foundation with Tanzu, available since version 4.0 of the platform, is a major architectural upgrade thanks to integration of Kubernetes directly into the vSphere hypervisor.

What allows Cloud Foundation to build a complete software-defined data center on VxRail is SDDC Manager and VxRail Manager software integration. SDDC Manager orchestrates the deployment, configuration, and lifecycle management of vCenter, NSX, and some of the vRealize Suite components above the ESXi and vSAN layers of VxRail. It enables VxRail clusters to serve as a resource platform for workload domains or as multi-cluster workload domains. It can also automatically enable VMware Tanzu for container-based workloads with built-in native Kubernetes orchestration. Integrated with the SDDC Manager management experience, VxRail Manager is used to deploy, configure, and lifecycle manage ESXi, vSAN and HCI infrastructure hardware firmware. VxRail lifecycle management is accomplished using fully integrated and seamless SDDC Manager orchestration that leverages VxRail Manager to execute it natively.

Through the standardized hardware and software architecture integrated into VMware Cloud Foundation on VxRail, customers can build heterogeneous workloads. Using SDDC Manager, infrastructure building blocks based on native VxRail clusters are created enabling customers to scale up and scale out incrementally.

VxRail Manager delivers automation, lifecycle management, support, and serviceability capabilities integrated with SDDC Manager and vCenter to extend the VMware Cloud Foundation management experience and simplify operations. VxRail Manager functionality is available in vCenter through an HTML5 plugin.

All VMware Cloud Foundation on VxRail lifecycle patching and upgrade operations are orchestrated using SDDC Manager. As a part of this monitoring, SDDC Manager automatically discovers when new VxRail and VMware Cloud Foundation updates are available for download and proactively notifies the administrator accordingly within the user interface. All updates are scheduled, executed, and orchestrated by SDDC Manager but may be executed by either SDDC Manager or VxRail Manager using integrated APIs.

Dell EMC delivers the #1 hyper-converged infrastructure portfolio purpose-built for HCI with the latest generation Dell EMC PowerEdge server platform. This portfolio delivers tailor-made performance and reliability powerful enough for any workload, combined with an advanced approach to intelligent deployment and operations that simplify and accelerate IT. Dell EMC HCI on latest generation PowerEdge servers are powerful and purpose-built platforms that provide the ideal foundation for software-defined data center initiatives.

VxRail nodes are available with different compute power, memory and cache configurations to closely match the requirements of new and expanding use cases. As requirements grow, the platform easily scales up or scales out in granular increments.

VMware Cloud Foundation on Dell EMC VxRail can be delivered as either a cluster of nodes that leverages the customer's existing network infrastructure, or as an integrated rack system with or without integrated networking. With rack assembly services from Dell EMC, VxRail rack integrated systems can be delivered with customer-chosen rack and networking component options.

Dell EMC Services accelerates the deployment of VMware Cloud Foundation on VxRail with a full range of integration and implementation services. Dell EMC Services helps IT organizations quickly realize the value of their investment both by deploying the hardware and software components of VMware Cloud Foundation on VxRail, as well as achieving IaaS through integration of this integrated cloud platform into their application portfolio, operating model, and enterprise infrastructure.

Customers have a choice of support and maintenance options that can align to their business model ranging from a single vendor Dell EMC support experience to obtaining support from Dell EMC, VMware, and third parties for network switches and racks. Dell EMC support is recognized with an over 95% customer satisfaction rating<sup>1</sup> and has received multiple awards.

VxRail Manager provides integration with Dell EMC Secure Remote Services (SRS) and other Dell EMC support related platforms, including online chat support and enabling the ability to open service requests from within its VxRail Manager vCenter plugin. The plugin also provides links to VxRail Community pages for Dell EMC Knowledgebase articles and user forums for FAQ information and VxRail best practices.

This paper also includes references of where to look for more information and an appendix to provide additional detail on VMware products used in the SDDC.

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<sup>1</sup> <http://i.dell.com/sites/doccontent/business/solutions/brochures/en/Documents/prosupport-enterprise-suite-brochure.pdf>

# Introduction

Information Technology (IT) departments are under significant pressure to deliver new applications to market, to innovate with technology to beat competitors and to do it faster with more choice. At the same time, there are requirements for stricter compliance, improved security, controlled costs and increased efficiency. To solve these problems, the modern data center is trending towards converged and hyper-converged infrastructures, virtualization and software-defined infrastructures and public and hybrid cloud solutions. See *Appendix B, Business IT challenges and trends* for a more detailed discussion of these issues.

The VMware vision of the modern data center is a software-defined, standardized architecture. It is a fully integrated hardware and software stack, simple to manage, monitor and operate. The VMware architecture for the software-defined data center (SDDC) empowers companies to run hybrid clouds and to leverage unique capabilities to deliver key outcomes that enable efficiency, agility and security. The VMware SDDC is based on VMware vSphere®, VMware vSAN® and VMware NSX® to provide compute, storage and networking virtualization to the SDDC, as well as the VMware vRealize® Suite for additional cloud management, self-service, automation, intelligent operations and financial transparency. See *Appendix C, VMware software-defined data center (SDDC)* for more detail.

VMware Cloud Foundation provides integrated cloud infrastructure (vSphere compute, vSAN storage, NSX networking, and security) and cloud management services (with the vRealize Suite) to run many types of enterprise applications, from traditional applications deployed as virtual machines and VMware Horizon virtual desktops, to Kubernetes powered containerized cloud native applications, in both private and public environments. VMware Cloud Foundation helps to break down the traditional administrative silos in data centers, merging compute, storage, network provisioning, and cloud management to facilitate end-to-end support for application deployment. VMware Cloud Foundation's SDDC Manager component automates the lifecycle management of a complete software-defined data center on standardized hyper-converged architecture. VMware Cloud Foundation can be deployed on premises on a broad range of supported hardware or consumed as a service in the public cloud. See *Appendix D, VMware Cloud Foundation* for more information on the native software platform architecture, key features and capabilities, SDDC Manager, resource management with workload domains, support for dual-region and multiple availability zones, and path to the hybrid cloud details.

Dell Technologies shares VMware's vision of the modern data center and extends that to the infrastructure. For customers that choose VMware as the primary technology for modernizing their data center or building a multi-cloud IT environment, Dell EMC offers an accelerated path to the VMware SDDC through the automation, extensive validation and documented guidance.

VMware Cloud Foundation on Dell EMC VxRail delivers a simple and direct path to the hybrid cloud and Kubernetes at cloud scale while allowing customers to maintain flexibility of networking and topology. VMware Cloud Foundation on VxRail builds upon native VxRail and VMware Cloud Foundation capabilities with additional unique Dell EMC and VMware jointly engineered integration features that simplify, streamline, and automate SDDC operations from deployment through day 2 operations, including support and serviceability capabilities that no other VMware Cloud Foundation infrastructure offer can provide.



# 1 VMware Cloud Foundation on Dell EMC VxRail

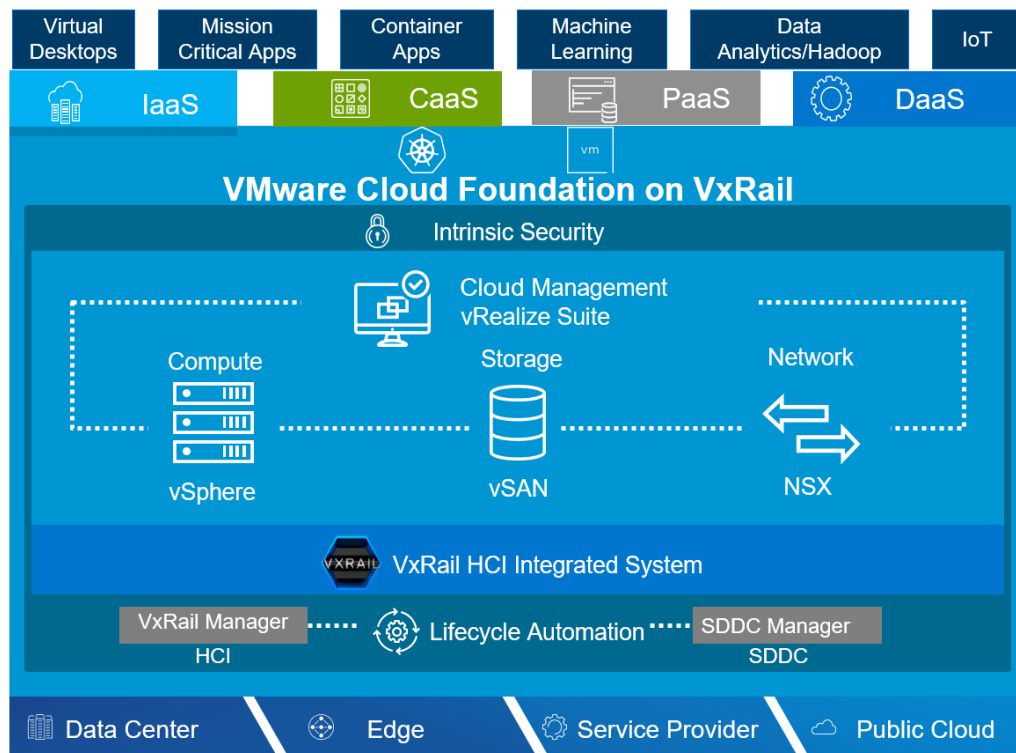
VMware Cloud Foundation on Dell EMC VxRail is a game changer and a unique Dell Technologies differentiated solution. It is an integrated VMware Cloud Foundation stack run on top of a VxRail HCI system that provides automated hardware and software lifecycle management and fully automated deployments of the VMware SDDC while still providing customers with flexible topologies and networking in one, complete, seamless user experience.

VMware Cloud Foundation leverages Dell EMC VxRail APIs to consume the value-added capabilities in VxRail. VMware has made architectural updates to the platform that pair well with core VxRail functionality such as networking flexibility enabling Dell EMC integration benefits, as well as deployment options ranging from a cluster of appliances to integrated rack offerings.

## 1.1 Operational hub for hybrid cloud

VMware Cloud Foundation on Dell EMC VxRail, the Dell Technologies Cloud Platform, provides a simple and direct path to the hybrid cloud through a fully integrated platform, that leverages native VxRail hardware and software capabilities and other VxRail unique integrations (such as vCenter plugin, SDDC Manager and VxRail Manager integration and VxRail architecture awareness built into Cloud Builder) to deliver a turnkey hybrid cloud user experience with full stack integration. Full stack integration means that customers get both the HCI infrastructure layer and cloud software stack in one, complete, automated lifecycle, turnkey experience. The platform delivers a set of software defined services for compute (with vSphere and vCenter), storage (with vSAN), networking (with NSX), security, cloud management (with vRealize Suite), and container based cloud native platform services (with VMware Tanzu) in both private or public environments making it the operational hub for your hybrid cloud. All of this makes it the operational hub for customers' hybrid clouds as shown in Figure 1.

**Figure 1** Operational hub for customers' hybrid cloud



### 1.1.1 Consistent hybrid cloud platform

The consistent hybrid cloud is a new paradigm that has emerged in the market, as a response to the complexity of multi-cloud raised in the *Business IT challenges and trends* section *B.5 Trend from legacy to modern applications and multi-cloud*.

VMware Cloud Foundation on Dell EMC VxRail provides a consistent hybrid cloud unifying customer public and private cloud platforms under a common operating environment and management framework. Customers can operate both their public and private platforms using one set of tools and processes, with a single management view and provisioning process across both platforms. This consistency allows for easy portability of applications.

An April 2019, IDC White Paper show that the consistent hybrid cloud platform (Dell Technologies Cloud) achieved savings of up to 47% over a five-year period compared with a native public cloud, when evaluated for typical applications being deployed on cloud infrastructure by enterprises today.<sup>2</sup> The TCO is based on the Dell Technologies Cloud Platform, which is based on VMware Cloud Foundation on Dell EMC VxRail. VxRail is built on mature hardware and the pervasive VMware stack and management tools and allows a non-disruptive path to adoption of multiple cloud platforms within an organization. This consistency across cloud platforms is the key differentiator defining the next generation of hybrid cloud — the consistent hybrid cloud platform.

## 1.2 How Dell EMC VxRail complements VMware's SDDC and hybrid cloud vision

Dell EMC VxRail is the foundation for the Dell Technologies Cloud Platform. Dell Technologies Cloud is a set of cloud infrastructure solutions, combining the power of VMware and Dell EMC infrastructure that is designed to make hybrid cloud environments simpler to deploy and manage.

Dell EMC VxRail is the foundation to deliver on the unified Dell Technologies Cloud Platform promise. Together, Dell EMC and VMware deliver consistent operations and a consistent infrastructure experience wherever the customer workloads may reside, from the core, to the edge, and to the cloud. VxRail's simplicity, scalability, and performance, along with its ongoing rapid pace of innovation, makes it a catalyst to accelerate IT transformation across the entire organization, with the added value of a robust ecosystem portfolio of products and services as part of Dell Technologies Cloud.

VxRail delivers the fastest and simplest path to achieving IT outcomes, from modernizing data center at the core with new platforms and faster network connectivity, to automated and accelerated hybrid cloud deployment with VMware Cloud Foundation on VxRail.

The Dell EMC VxRail turnkey experience starts with full stack integration of software and hardware together, for a consistent, deeply integrated VMware environment. VxRail goes even further to deliver even more highly differentiated features and benefits based on the VxRail HCI system software, which automates deployment, delivers complete lifecycle management, and facilitates key upstream and downstream integration points that create a truly better together experience with VxRail as the foundation. VxRail is the only jointly engineered

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<sup>2</sup> <https://www.dell.com/en-us/collaterals/unauth/analyst-reports/products/dell-technologies-cloud/idc-cost-benefits-analysis-of-dell-technologies-cloud-solution.pdf>

HCI system with VMware, and supports synchronous releases with VMware so the latest HCI and cloud software benefits are available to customers sooner.

For customers that choose VMware as the primary technology for modernizing their data center or building a multi-cloud IT environment, Dell EMC offers both automated and guided paths to the VMware SDDC.

### 1.2.1 VMware Cloud Foundation on Dell EMC VxRail

VMware Cloud Foundation on VxRail builds upon native VxRail and Cloud Foundation capabilities with additional unique Dell EMC and VMware jointly engineered integration features that simplify, streamline, and automate the operations of your entire SDDC from deployment through day 2 operations, including support and serviceability capabilities that no other VMware Cloud Foundation infrastructure offering can provide.

Full-stack integration with VMware Cloud Foundation on VxRail means both the HCI infrastructure and VMware cloud software stack lifecycle are managed as one seamless, complete, automated, turnkey hybrid cloud experience greatly reducing risk and increasing IT operational efficiency. VMware Cloud Foundation on VxRail delivers a consistent infrastructure and consistent operations experience with edge, private and native public cloud workload deployment options for a true hybrid cloud solution.

VMware Cloud Foundation on Dell EMC VxRail can be delivered several ways while providing customers with the flexibility to use their own or Dell networking:

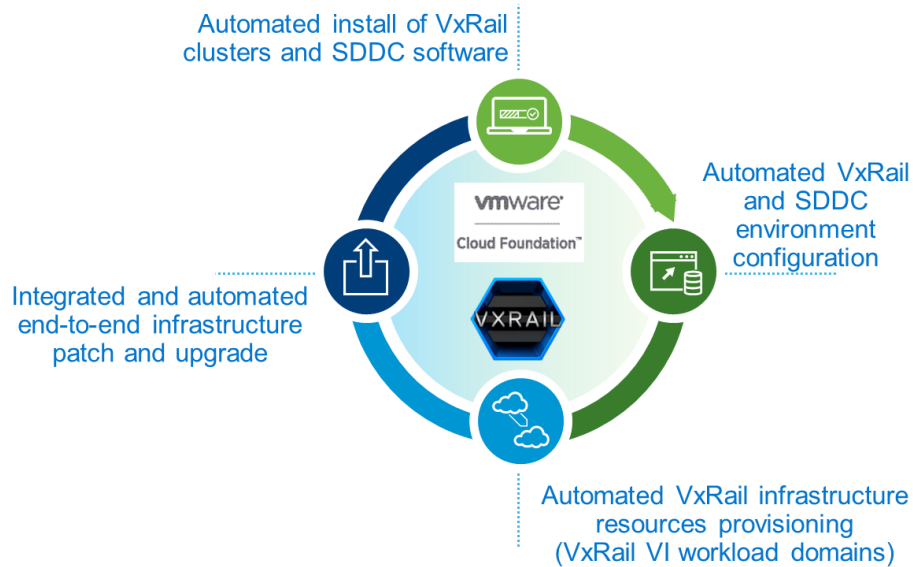
- A cluster of nodes where customers can integrate it into their own racks with their choice of existing networking components.
- An integrated rack system with integrated networking built and delivered to a customer's site, saving hours of building and testing the infrastructure themselves.

Based on VMware SDDC best practices, VMware Cloud Foundation on VxRail ensures customers are future-proofed for next generation VMware cloud technologies that will be innovated around the same architectural design principles.

## 1.3 Full stack integration

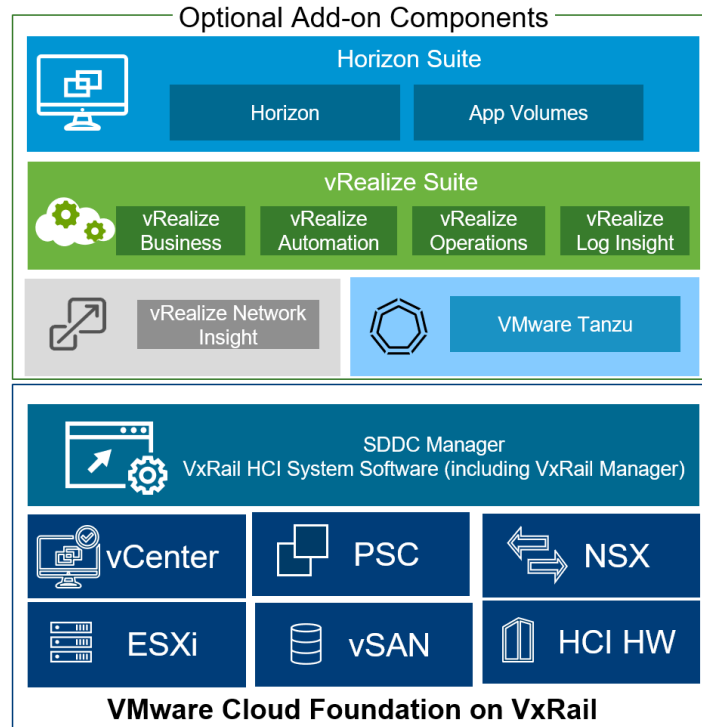
VMware Cloud Foundation on VxRail makes operating the data center fundamentally simpler by bringing the ease and automation of the public cloud in-house by deploying a standardized and validated network flexible architecture with built in lifecycle automation for the entire cloud infrastructure stack including hardware. As shown in Figure 2, full stack automation is in place for day 0, day 1 and day 2 operations. On day 0, there is the automated deployment and installation of VxRail clusters and SDDC software. On day 1, there is the automated environment configuration and resource provisioning. On day 2 there is automated end-to-end infrastructure patch and upgrade.

**Figure 2** VMware Cloud Foundation on VxRail delivers end-to-end stack lifecycle automation



Core components for VMware Cloud Foundation on VxRail come from both VxRail and Cloud Foundation. VxRail provides the base HCI hardware, ESXi, vCenter, vSAN, VxRail Manager and Dell EMC SRS appliance. Cloud Foundation provides SDDC Manager, NSX and vRealize Log Insight (core includes license for the Management Domain only). Optional add-on components include the VMware vRealize Suite: VMware vRealize Operations™, VMware vRealize Log Insight™ (additional license for workload domains), VMware vRealize Automation™, VMware vRealize Business for Cloud™; VMware vRealize Network Insight™, VMware Horizon® Suite: Horizon, and VMware App Volumes™; and VMware Tanzu. Figure 3 illustrates the VMware Cloud Foundation on VxRail core and optional components.

To learn more about the VMware SDDC components listed above, please check the Appendix D, *VMware Cloud Foundation* and Appendix E, *VMware SDDC common component details*.

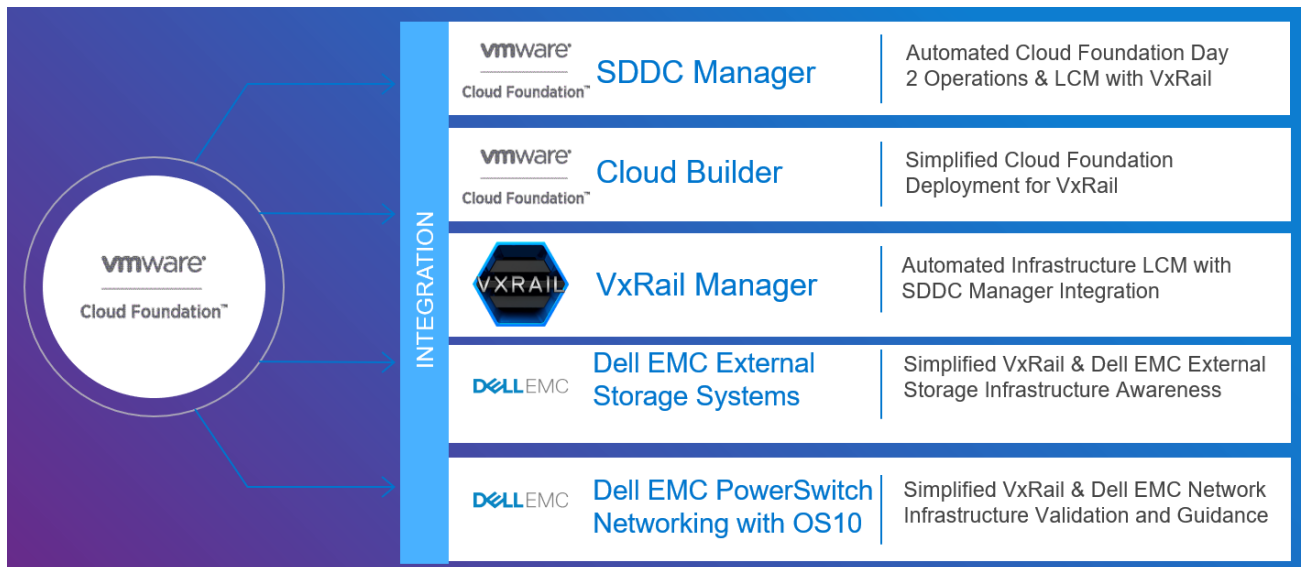
**Figure 3** VMware Cloud Foundation on VxRail core and optional components

Every VxRail provides the benefits of a jointly engineered HCI appliance that is built for VMware and is powered by vSphere, vSAN, and VxRail HCI System Software (which includes VxRail Manager) according to standardized HCI designs. With VxRail, a customer gets several highly valuable built-in features that are driven by the capabilities of VxRail HCI System Software. These include scalable VxRail deployments, VxRail cluster creation and node add/remove capabilities, serviceability creation in vCenter, vCenter plugin for VxRail workflow automation, and more.

Every VMware Cloud Foundation on VxRail deployment is based on the standardized architecture. VMware has validated the suite of components (vSphere, vSAN, NSX, vRealize Suite, Tanzu, etc.), that when used together, provide all of the data center virtualization and cloud management services a customer needs to build a private cloud. VMware takes these components, performs interoperability testing on them, but also develops a set of standardized component level designs on how they should be configured with each other according to VMware best practices. It is when you combine both the component qualification with a set of documented and validated standardized SDDC level architecture designs that you have a fully validated SDDC design.

**Error! Reference source not found.** shows how Dell Technologies joint engineering efforts for VMware Cloud Foundation on VxRail fit together and what unique value-added features are introduced by each component.

**Figure 4** VCF on VxRail deep integration features that simplify, streamline, and automate operations of SDDC



Let's discuss these, starting from the bottom of the diagram:

- Dell EMC PowerSwitch Networking with OS10**

VxRail has been qualified with Dell EMC PowerSwitch with OS10 Enterprise Edition networking switches. There's a documented guidance on how to deploy Dell EMC network switches for VCF on VxRail deployments are available along with tools like the Dell Networking Fabric Design Center to help architect the right network architecture based on customer's requirements.
- VxRail & Dell EMC External Storage Infrastructure Awareness integration**

VCF on VxRail deployments can inherit the benefits of integration efforts engineered between VxRail and Dell EMC external storage systems that make VxRail "external storage system aware". This enables administrators to leverage existing Dell EMC external storage investments in their VCF on VxRail environments while maintaining a simple and consistent operations experience, they are used to with VxRail.
- VxRail Manager**

It is the primary management and automation tool used for VxRail cluster operations with end-to-end LCM – from automated deployment and configuration through serviceability and support experience. An example is native integration within VxRail Manager with SRS Connect-Home support as well as capabilities to automate serviceability tasks such as proactive drive replacements. VxRail Manager extensibility is a key enabler to how VCF and VxRail are integrated.
- VMware Cloud Builder**

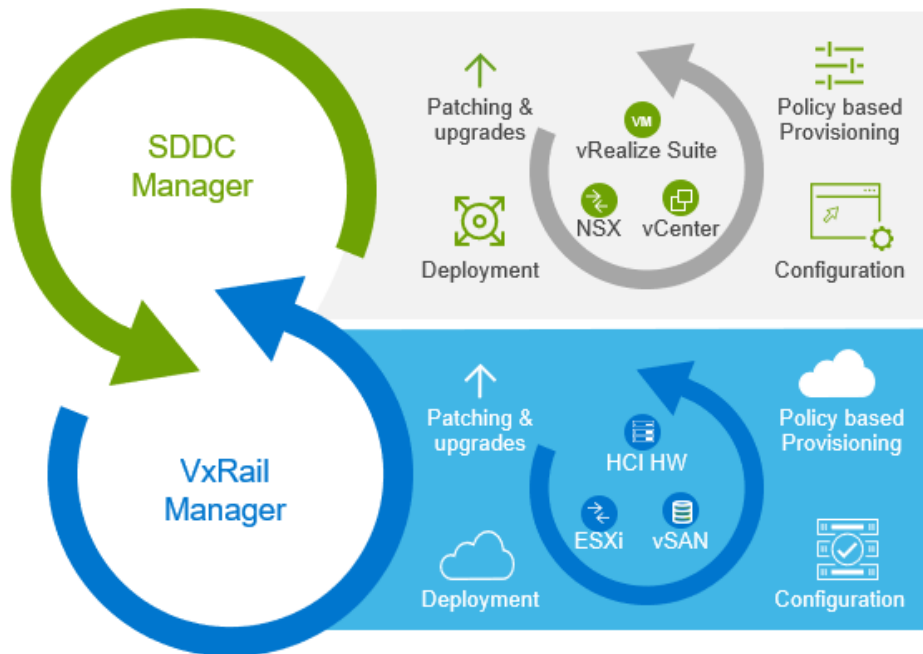
VMware Cloud Builder is a standardized and automated SDDC deployment tool that has been made "VxRail aware" through VMware and Dell EMC co-engineering efforts. Cloud Builder helps automate the day 0 deployment of the VMware SDDC components and configure them according to the VMware's SDDC best practices and standardized architecture, and can do so specifically on top of VxRail infrastructure. Essentially, Cloud Builder deploys VMware Cloud Foundation on top of what VxRail Manager has already configured when deploying a VxRail cluster saving customers time and effort when setting up their SDDC infrastructure stack.

- VMware SDDC Manager**  
 Dell EMC and VMware joint engineering integration have added capabilities to SDDC Manager, exclusive for running VMware Cloud Foundation for VxRail software on VxRail. These include integration between SDDC Manager and VxRail Manager to provide automated creation of vCenter and VxRail Workload Domains using NSX-T, automation for SDDC and VxRail Managers, and an industry exclusive, full end-to-end lifecycle automation management for the VxRail clusters and VMware SDDC software stack.

## 1.4 Integrated platform management

What allows VMware Cloud Foundation to build a complete SDDC on VxRail is the SDDC Manager and VxRail Manager software tool integration shown in Figure 5. SDDC Manager orchestrates the deployment, configuration, and lifecycle management of vCenter, NSX, and vRealize Suite above the ESXi and vSAN layers of VxRail. It unifies multiple VxRail clusters as workload domains or as multi-cluster workload domains. Integrated with the SDDC Manager management experience, VxRail Manager is used to deploy, configure, and lifecycle manage ESXi (which now includes VCF with Tanzu since it is now integrated into vSphere), vSAN and hardware firmware taking advantage of the native VxRail Continuously Validated State update bundle framework, which is only available through the VxRail HCI System Software. The deployment of VxRail clusters uses the native VxRail Manager first run cluster creation process. For VxRail LCM, it is seamlessly integrated into the SDDC Manager orchestrated LCM workflows that use VxRail Manager to execute it natively. VxRail Manager also monitors health of hardware components and provides remote service support.

**Figure 5** VxRail Manager and SDDC Manager integration





## 1.5 Scalable and flexible platform for heterogeneous workloads

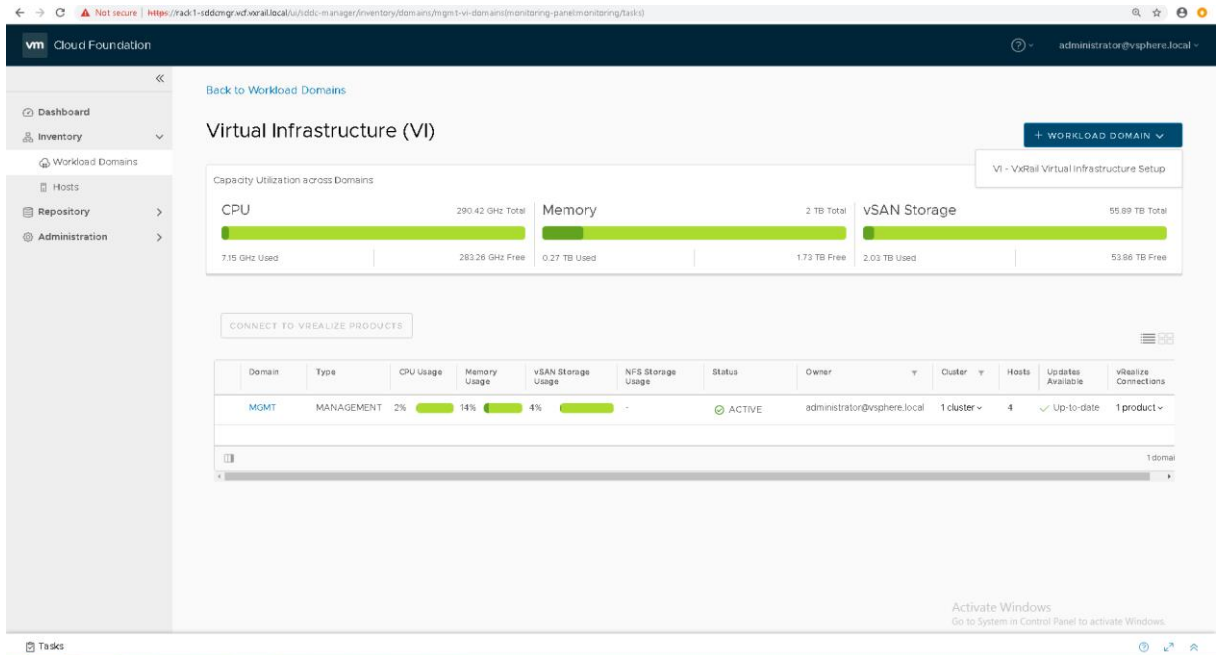
Through the standardized hardware and software architecture integrated into VMware Cloud Foundation on VxRail, customers can build heterogeneous workloads. Using SDDC Manager, infrastructure building blocks based on native VxRail clusters are created that can scale up and out incrementally.

Starting with 4 nodes, customers can scale up leveraging the flexible hardware configurations available within a VxRail node to increase storage capacity or memory. Customers can similarly scale out by adding nodes in single node increments to a cluster. The physical compute, storage and network infrastructure becomes part of a single shared pool of virtual resources that is managed as one cloud infrastructure ecosystem using the SDDC Manager. From this shared pool, customers can organize separate pools of capacity into what are called workload domains, each with its own set of specified CPU, memory and storage requirements to support various workloads. As new VxRail physical capacity is added, it will be recognized by the SDDC Manager and made available for consumption as part of a workload domain.

In VCF 4.0 on VxRail 7.0 or above, there are two types of workload domains that can be deployed: a VxRail virtual infrastructure (VxRail VI) workload domain, and a special workload domain called the Management domain. VxRail VI workload domains are created by simply clicking **+ WORKLOAD DOMAIN** in SDDC Manager. This process has been co-engineered by design to leverage the existing VxRail cluster deployment process in order to maintain a consistent operational experience for VxRail customers. Each workload domain can have administrative tasks performed against it such as create, expand, and delete. The management domain is the only one that is not allowed to be deleted; and it is created during initial system install (also referred to as “Bring Up”). Figure 6 displays the SDDC Manager Workload Domain details screen after clicking the **+ WORKLOAD DOMAIN** button in the top right, with the option showing the VxRail integration to create a **VxRail Virtual Infrastructure Setup**.

Starting with VCF 4.0 on VxRail 7.0, it is possible to leverage only NSX-T for software-defined networking within VxRail VI workload domain. NSX-T is the next generation, hypervisor independent SDN platform from VMware, which is in the center of current innovations in this space and is expected to replace NSX-V in the near future. To learn more about NSX-T, please consult Appendix E, *VMware SDDC common component details*.



**Figure 6** Launching the create VxRail VI workload domain dialog in SDDC Manager

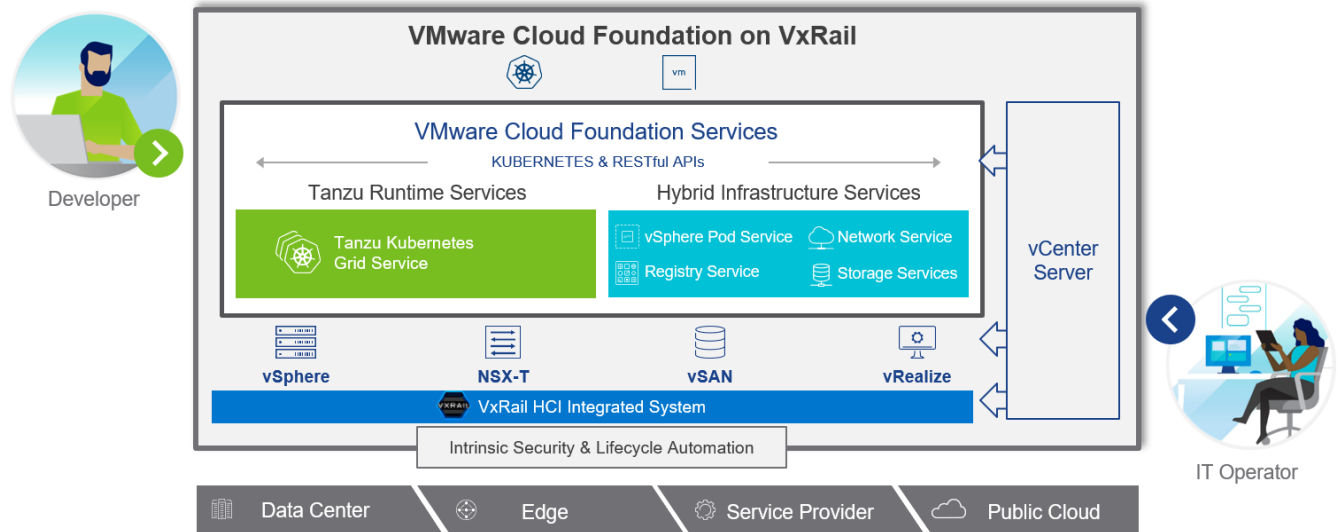
Starting with VMware Cloud Foundation 4.0 on VxRail 7.0, the platform supports consolidated architecture, which is an attractive proposition for customers who value more reduced footprint of the cloud platform than clear separation of management infrastructure from workloads. In the consolidated architecture, customer's workloads co-exist within the management workload domain, reducing the entry point to as little as four nodes at the expense physical separation of management and flexibility of LCM upgrades.

Customers may choose to enable VMware Cloud Foundation with Tanzu functionality on both VxRail virtual infrastructure workload domain and the Management Domain – more details on this new functionality in the next chapter.

## 1.6 Support for Kubernetes-based cloud native platform services

VMware Cloud Foundation 4.0 of VxRail 7.0 is a major architectural upgrade to the platform - the biggest innovation included in this version is VMware Cloud Foundation with Tanzu, providing native integration of Kubernetes directly into the vSphere Hypervisor (previously known as Project Pacific). This integration delivers a new set of VMware Cloud Foundation Services, including VMware Tanzu Runtime Services and Hybrid Infrastructure Services, that provide the bases for the cloud infrastructure and container ecosystems to accelerate developer productivity.

With VMware Cloud Foundation 4, virtual infrastructure admins get unified visibility of virtual machines (VMs), containers, and Kubernetes clusters directly in vCenter Server, which is also the standard management console for VxRail, they are very familiar with. Containers and Kubernetes are managed alongside VMs from the same console and the concept of Kubernetes namespace is integrated into vSphere, becoming the unit of management. Resource objects, such as VMs and containers can be grouped into logical applications via namespaces, simplifying the management of cloud-native workloads at scale. Admins can set policies, quota and role-based to a namespace, allowing developers to access the namespace within the pre-defined boundaries.

**Figure 7** VMware Cloud Foundation 4 with Tanzu on VxRail 7 (services view)

On the other hand, developers can create both Supervisor Clusters and Guest Clusters. Supervisor Clusters run Kubernetes natively on ESXi for better container performance and integration, while Guest Clusters that run Kubernetes in Tanzu Kubernetes Grid (TKG) clusters on VMs. Similarly to VMware admins, who can manage Kubernetes environment in vSphere using their native management tools (i.e. vCenter), developers can consume cloud resources such as Kubernetes clusters, disks and networks using Kubernetes CLI and API tools they are familiar with (see Figure 6 above).

Let's summarize key benefits of VMware Cloud Foundation with Tanzu functionality introduced in version 4 of the platform:

- **Application-focused management bringing VMs and containers onto the same platform** – thanks to unified visibility of virtual machines (VMs), containers, Kubernetes clusters in vCenter and integration of Kubernetes namespace concept as the management entity into vSphere.
- **Enterprise-class resiliency, QoS, security, and access control for both VMs and containers** – admins can define QoS, security policies, firewall rules, encryptions settings, availability and backup rules, and access rules at namespace level; additionally, NSX-T integration with Kubernetes enables context-aware security policies with namespace isolation.
- **Developer self-service APIs to boost productivity** – developers can create and consume cloud resources such as Kubernetes clusters, volumes, and networks with VMware Cloud Foundation Services using Kubernetes and RESTful APIs that they are familiar with.
- **Rapid application deployment with full stack agility** – VMware Cloud Foundation automates deployment not only of the underlying infrastructure (workload domain) but also Kubernetes components.

- **Enhanced infrastructure lifecycle management** – thanks to automated lifecycle management on a per-workload domain basis.
- **Full stack networking and intrinsic security at every layer of the stack** – e.g. with container registry from Tanzu Kubernetes Grid, that has built-in vulnerability scanning, image signing, and auditing (container image layer), vSphere comprehensive built-in security for protecting data, infrastructure, and access (compute layer) and NSX-T delivering micro-segmentation and granular security to the individual VM or pod workload (network layer).
- **Cloud operating model extending across private and hybrid cloud** – the same SDDC stack leveraged in private cloud deployments of VMware Cloud Foundation is also the underpinning technology of VMware-based public cloud offerings like VMware Cloud on AWS, other VMware Cloud Provider Program partners, as well as VMware Cloud on Dell EMC, resulting in consistent infrastructure and operations.

VMware vSAN as a core component of VMware Cloud Foundation on VxRail includes CSI driver that enables developers to provision persistent storage for Kubernetes on vSphere on-demand in an automated fashion. VMware admins can manage container volumes through the Cloud Native Storage UI within VMware vCenter as if they were VM volumes. Developers and IT administrators can have a consistent view of container volumes and troubleshoot at the same level.

Cloud Native Storage through the CSI driver on vSAN is natively integrated into vCenter and provides comprehensive data management for both stateless and stateful applications. Customers using cloud native storage can create containerized stateful applications capable of surviving container restarts and outages. Stateful containers leverage storage exposed by vSphere that can be provisioned using Kubernetes primitives such as persistent volume, persistent volume claim, and storage class for dynamic provisioning.

With NSX-T, another key component of VMware Cloud Foundation stack, there is no need for end users to know the underlying network architecture. Networking can be easily managed with Kubernetes clusters – deployment, upgrade and scaling out. NSX-T can automatically create load balancers, routers, switches to be used by Tanzu. It also provides end-to-end security by firewalls, namespace isolation, etc.

To learn more about the VMware Tanzu portfolio, please check the Appendix *E*, *VMware SDDC* common component details.

## 1.7 VxRail HCI System Software and VxRail Manager

VxRail HCI System Software consists of multiple, integrated software elements that extend VMware native capabilities to deliver a seamless, automated, operational experience, keeping the infrastructure in a pre-validated configuration to ensure workloads are consistently up and running. VxRail HCI System Software is pre-installed on the VxRail system as a single virtual machine. The software services in VxRail HCI System Software can be grouped into three main areas: lifecycle management for predictable outcomes, management flexibility and extensibility, and simplified services and support experience.

Lifecycle management for predictable outcomes:

- Automated, intelligent lifecycle management (LCM) functionality automatically updates clusters with pre-validated, pre-tested software and firmware components, ensuring the HCI stack is in a Continuously Validated State.

- The electronic compatibility matrix serves as a compliance asset providing validation that all possible configuration and upgrade path permutations are sound, enabling customers to choose the Continuously Validated State of their choice to optimize each cluster for its respective workloads.
- Ecosystem connectors tightly integrate with infrastructure components including vSAN, PowerEdge server components and networking, enabling automation and orchestration services across the entire stack for simple cluster software and firmware updates.

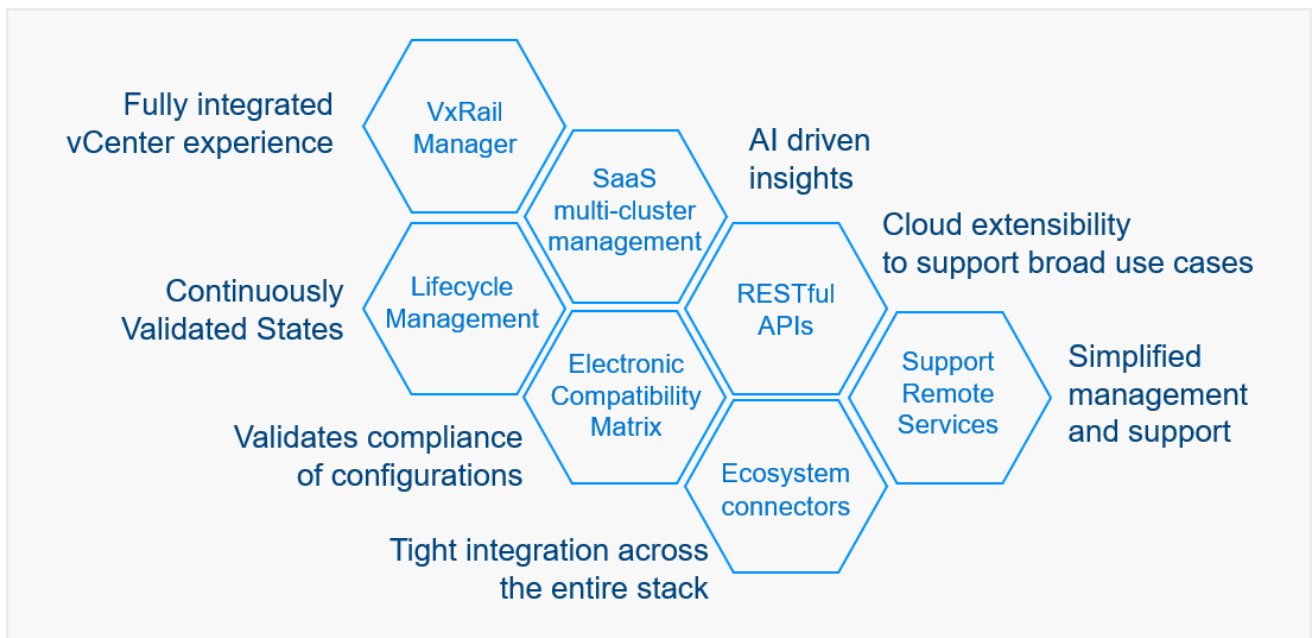
Management flexibility and extensibility:

- VxRail Manager, natively integrated with and accessed via vCenter, is the overall management engine for all VxRail operations to deploy, manage, upgrade, patch and add nodes to a cluster.
- A broad set of publicly available RESTful APIs are provided to customers to deliver greater cloud and IT automation extensibility.

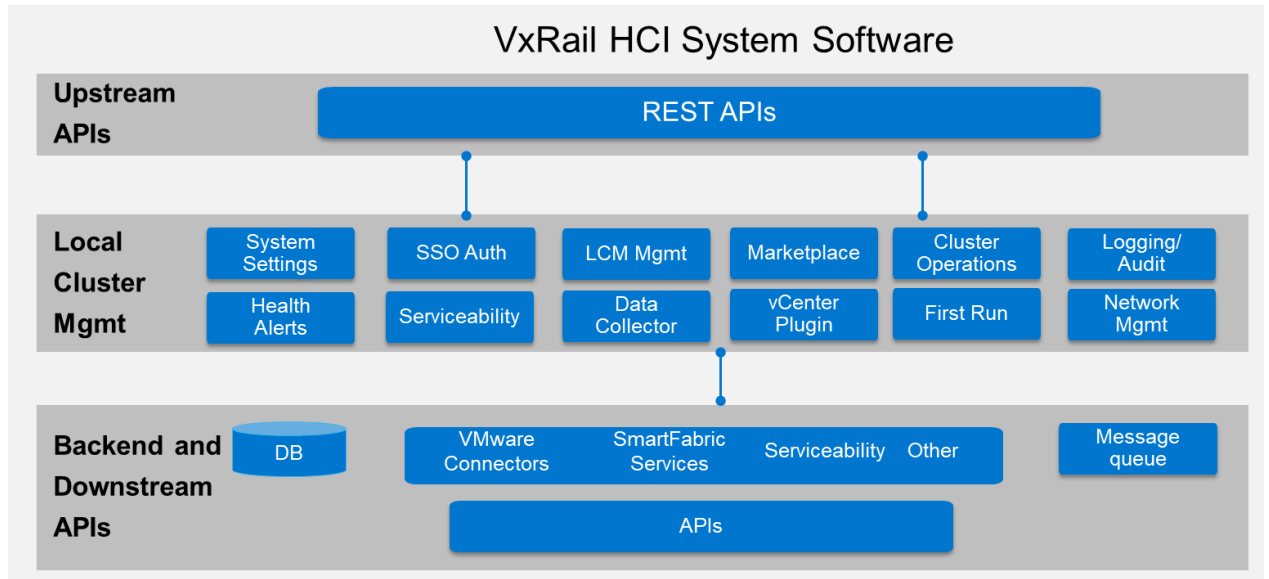
Simplified services and support experience:

- Customers always have access to Dell EMC Secure Remote Services (SRS) for all included hardware and software within VxRail throughout the entire lifecycle of the infrastructure.

**Figure 8** Core components of VxRail HCI System Software



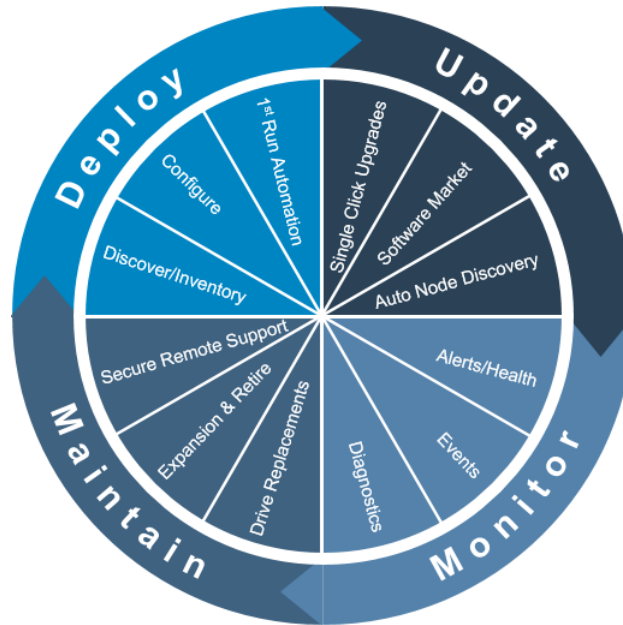
VxRail HCI System Software architecture is shown in Figure 9. When used for a cloud deployment use case, the VxRail HCI System Software sits in between the infrastructure layer and cloud orchestration software. Local management features include vCenter Plug-ins, LCM, Serviceability via eServices and SRS, and Health Alerts. The extensibility of VxRail HCI System Software is available to VMware SDDC solutions like VMware Cloud Foundation including backend APIs, SaaS multi-cluster management, and open REST APIs for configuration management solutions (i.e. Puppet, Ansible).

**Figure 9** VxRail HCI System Software architecture

### 1.7.1 VxRail Manager

VxRail Manager features user-friendly workflows for automating VxRail deployment and configuration and monitoring the health of individual systems in the entire cluster. It also incorporates functionality for hardware serviceability and system platform lifecycle management. For instance, it guides system administrators through adding new systems to an existing cluster, and it automatically detects new systems when they come online. VxRail Manager is also used to replace failed disk drives without disrupting availability, to generate and download diagnostic log bundles, and to apply VMware updates or software patches non-disruptively across VxRail nodes.

With VxRail Manager plug-in for vCenter Server, all VxRail Manager features are integrated with and accessible from the vCenter Server so that users can benefit from these valuable capabilities on a familiar management interface. With the VxRail Manager plug-in, the vCenter Server can manage physical hardware of the VxRail cluster.

**Figure 10** Dell EMC VxRail Manager

VxRail also leverages VMware vRealize Log Insight to monitor system events and provide ongoing holistic notifications about the state of virtual environment and system hardware. It delivers real-time automated log management for the VxRail system with log monitoring, intelligent grouping, and analytics to provide better troubleshooting at scale across VxRail physical, virtual, and cloud environments. Furthermore, VxRail HCI System Software simplifies system platform lifecycle management by delivering patch software and update notifications that can be automatically installed without interruption or downtime.

Dell EMC Secure Remote Services (SRS), also accessible from within VxRail Manager plug-in or REST API, provide enterprise-class support and services. SRS includes online chat support and Dell EMC field-service assistance.

In addition to SRS-specific support, the VxRail Support page on vCenter Server links to VxRail Community pages for Dell EMC Knowledge Base articles, user forums for FAQ information and VxRail best practices.

The VxRail Manager functionality visible through the HTML5 vCenter plugin can be illustrated with the following screenshots. Figure 11 displays a vCenter view showing the VMware Cloud Foundation management domain and workload domain built on VxRail clusters.

**Figure 11** vCenter view showing VMware Cloud Foundation management domain and workload domain

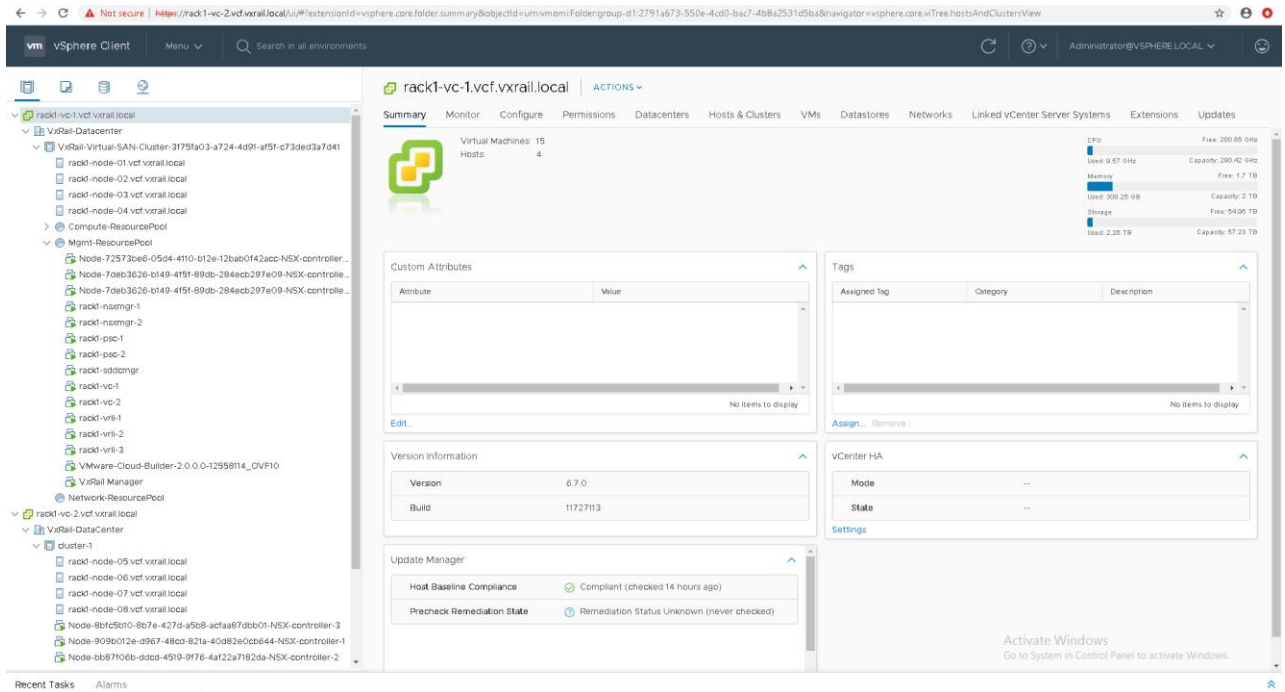
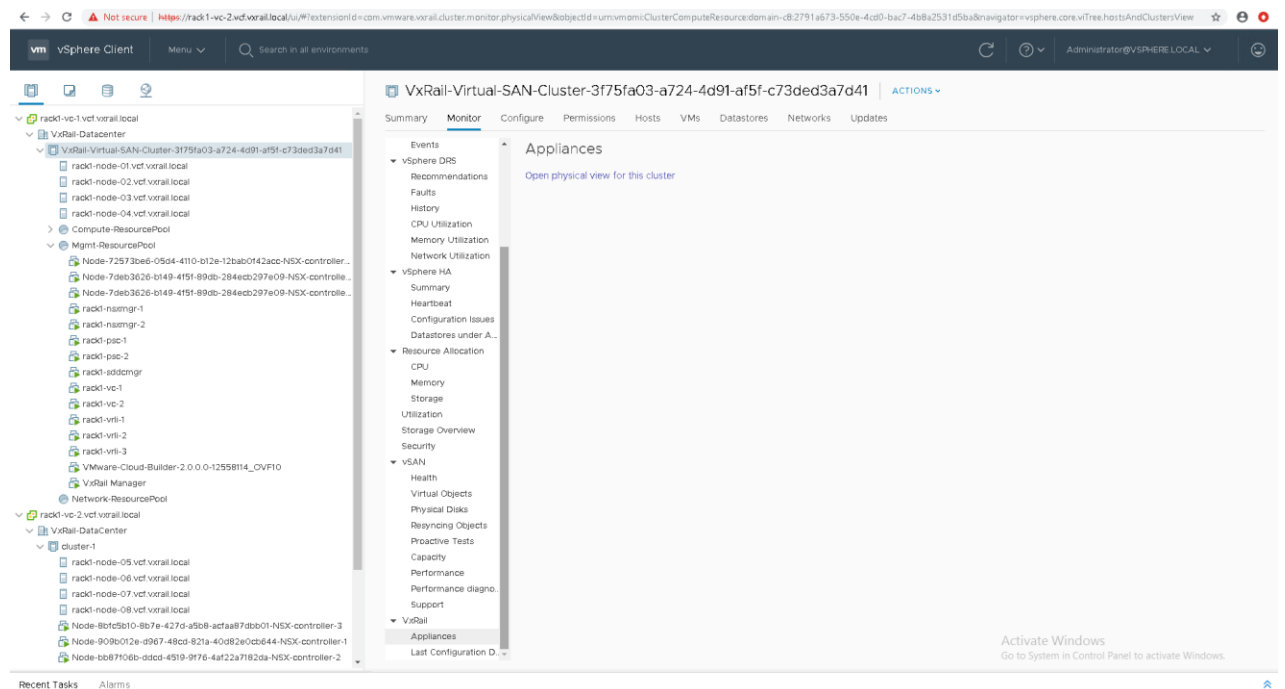


Figure 12 displays navigating to the vSAN cluster level, choosing the Monitor tab and selecting Appliances to get to the link to open the VxRail Manager provided physical view for this cluster.

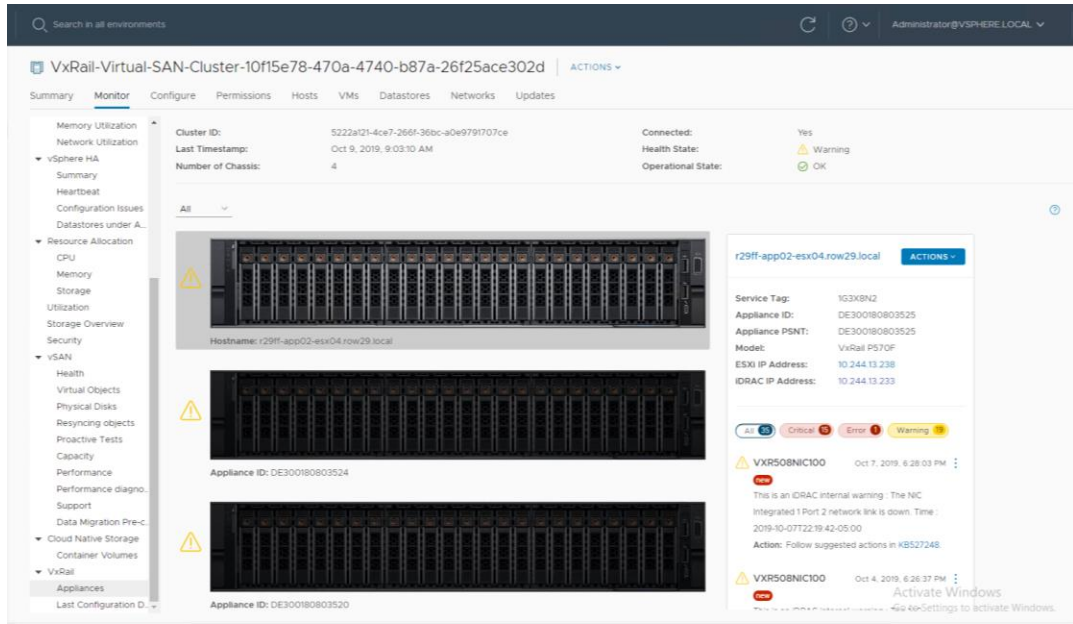
**Figure 12** Navigating to open the cluster VxRail physical view





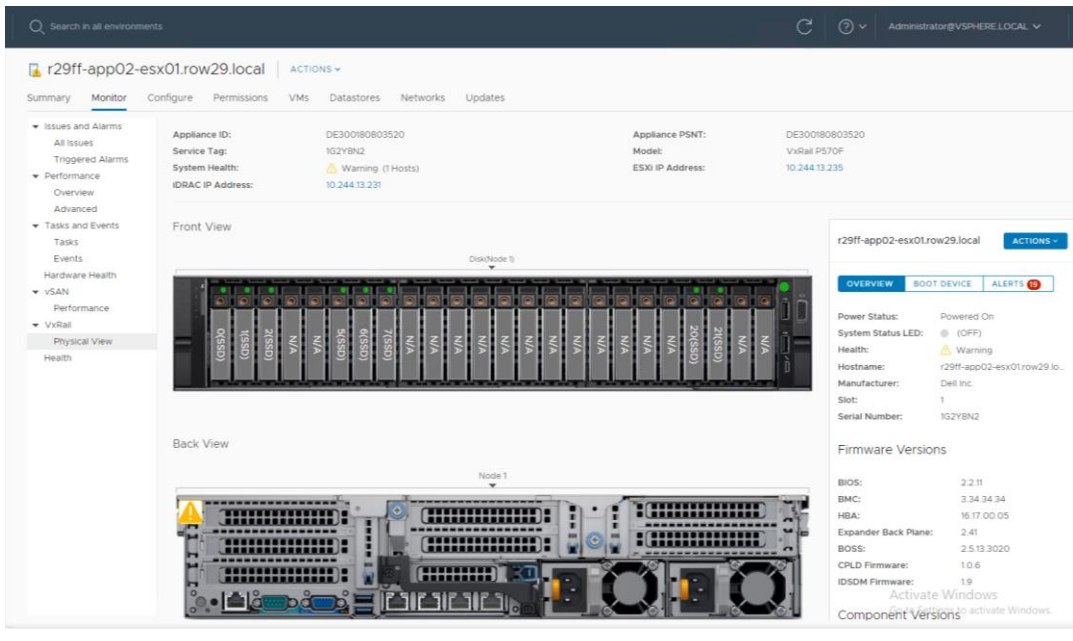
The top level four node management cluster VxRail Hardware view is displayed in Figure 13

**Figure 13** VxRail cluster physical view



Drilling down on the physical views can present additional detail including the display shown in Figure 14 of a hardware view used for instance for disk hardware replacement.

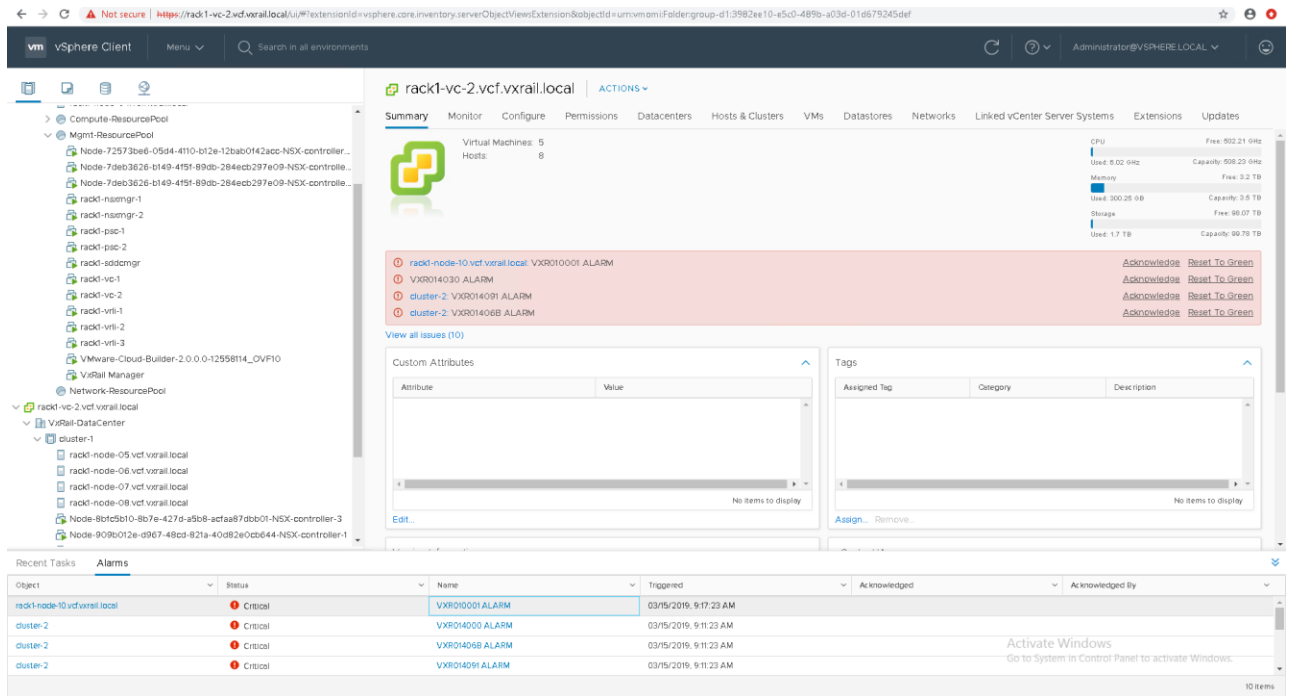
**Figure 14** VxRail disk hardware replacement screen





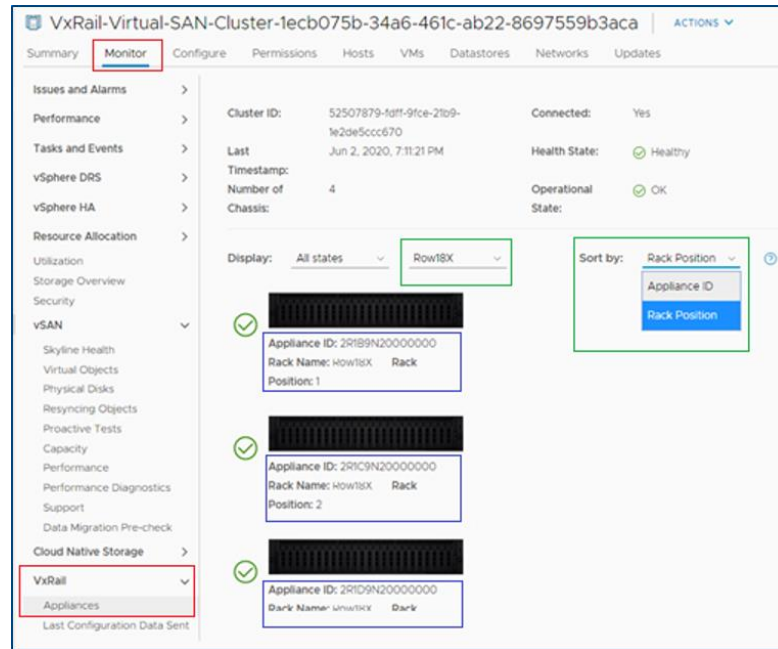
Detailed VxRail hardware component level events and alerts are collected by VxRail Manager and displayed in vCenter as part of the integrated vCenter HTML5 plugin. This provides holistic, system-level health awareness within the SDDC management framework. Failure events are passed to vCenter. Alarms from VxRail start with the prefix 'VXR'. Figure 15 shows an example in vCenter displaying VxRail hardware alarms.

**Figure 15** Example of VxRail hardware alarms in the vCenter HTML5 plugin



With VxRail HCI Software version 7.0.010 (and above), VxRail Manager supports geographic location tags for VxRail nodes. The capability allows for important user defined node meta data that can assist many customers in gaining greater visibility of the physical location mapping of the HCI infrastructure that makes up their cloud. Customers can leverage this data to choose VxRail the node/host order they want to be displayed in the VxRail Manager vCenter plugin Physical View. These geo\_location host attribute tags can be applied during VxRail Day1 cluster installation or during node expansion and host edit Day 2 operations.

This provides customers with full stack physical to virtual infrastructure mapping to help further extend the VMware Cloud Foundation management experience and simplify operations only available with VCF on VxRail (see Figure 15).

**Figure 16** Example of VxRail geo\_location host tags in the vCenter plugin

## 1.7.2 REST APIs

VxRail HCI System Software includes APIs that enables you to leverage the full power of automation and orchestration services across your data center. This extensibility enables you to build and operate infrastructure with cloud-like scale and agility and streamlines the integration of the infrastructure into your IT environment and processes. Instead of manually managing your environment through the graphical user interface, repeatable operations can be triggered and executed programmatically by software. More and more customers are embracing DevOps and Infrastructure as Code (IaC) models as they need reliable and repeatable processes to configure the underlying infrastructure resources required for applications. IaC leverages APIs to store configurations in code, making it repeatable and greatly reduces errors.

VxRail API is a feature of VxRail HCI System Software, that exposes management functions with a RESTful application programming interface. It's designed for ease of use by VxRail customers and ecosystem partners, who would like to better integrate 3<sup>rd</sup> party products with VxRail system.

VxRail API was designed to complement VMware REST APIs, such as vSphere Automation API, and focuses on the underlying infrastructure and unique automated lifecycle management capabilities. VxRail API can be used in combination with VMware Cloud Foundation on Dell EMC VxRail API, which is supported since version 4.0 of the platform. Most of the operations that required SDDC Manager UI can now be executed using API. This is an area of extensive development with new capabilities growing over time, important especially for service providers, who are leveraging VMware Cloud Foundation on VxRail as a platform to deliver cloud-based services for their customers.

To learn more about VxRail API, please check the following [solution overview](#). For additional information on VMware Cloud Foundation on VxRail API, please consult the API [reference](#) guide.

## 1.8 Integrated lifecycle management

Data center upgrades and patch management are typically manual, repetitive tasks prone to configuration and implementation errors. Validation testing of software and hardware firmware to ensure interoperability among components when one component is patched or upgraded requires extensive quality assurance testing in staging environments. Strapped for time, IT must sometimes make the difficult decision to deploy new patches before they are fully vetted or to defer new patches, which slows down the roll-out of new features, security and bug fixes. Both situations increase risk for the customer environment.

To help understand lifecycle operations details, it is helpful to better understand the VMware Cloud Foundation concept of a Workload Domain. A Workload Domain is a policy-based resource container with specific availability and performance attributes that combines compute (vSphere), storage (vSAN), and networking (NSX) into a single consumable entity. In the case of running VMware Cloud Foundation on VxRail, these workload domains are built using VxRail clusters and leverage the native VxRail operations experience for tasks such as automated cluster builds and cluster expansions as examples.

Infrastructure building blocks can be created based on native VxRail clusters that can scale up and out incrementally. Customers can scale up leveraging the flexible hardware configurations available within a VxRail node to increase storage capacity or memory. Customers can similarly scale out by adding nodes in single node increments to a cluster. The physical compute, storage and network infrastructure becomes part of a single shared pool of virtual resources that is managed as one cloud infrastructure ecosystem using the SDDC Manager.

From this shared pool, customers can organize separate pools of capacity into what are defined as Workload Domains, each with its own set of specified CPU, memory and storage requirements to support various workload types such as cloud native, VDI or business critical apps like databases, etc. As new VxRail physical capacity is added, it will be recognized by the SDDC Manager and be made available for consumption as part of a workload domain. Scaling workload domains beyond a single cluster gets even easier with the ability to add multiple VxRail clusters within a workload domain.

Workload Domains can be created, expanded, and deleted. They can also be patched/upgraded independently, providing customers with the flexibility to align workload domain infrastructure requirements to the applications running on them. And it is in this concept that we come back to our lifecycle management discussion. With VMware Cloud Foundation, all lifecycle management occurs at the workload domain level. Note, that with the enhancements introduced in VMware Cloud Foundation 4.0.1, if needed customers may manage upgrades on a more granular, cluster level, including VMware Tanzu enabled clusters.

### 1.8.1 Lifecycle Management (LCM) end-to-end process details

VMware Cloud Foundation on VxRail leverages both the native Cloud Foundation and VxRail HCI System Software update bundles for its updates. This means that there is no proprietary package that needs to be generated specifically for running VMware Cloud Foundation on VxRail that would delay the availability of these updates from being published for customer consumption when the updates are available. This allows both VMware and Dell EMC to innovate faster within their respective layers asynchronously, bringing about newer features/changes without affecting the other layers of the platform stack. It also means that VMware and Dell EMC can continue to leverage their respective streamlined development and release processes for both VxRail and Cloud Foundation independently. All this means that new versions of VMware Cloud Foundation on VxRail allow customers to take advantage of new platform features faster.

VxRail LCM is built on Ecosystem Connectors to integrate vSAN cluster software and PowerEdge server hardware so that the ESXi host can be managed as a single system. This system integration enables automation and orchestration necessary to deliver non-disruptive, streamlined HCI stack upgrades. Where VxRail LCM delivers differentiated value is the ability to deliver pre-validated set of software and firmware that ensures compatibility and compliance of the entire configuration on HCI stack while maintaining the performance and availability required of the virtualized workloads running on the clusters.

The ability to test, validate, and produce a VxRail software bundle to support every vSphere release, any-to-any version upgrade path, and the millions of VxRail configurations is termed as Continuously Validated States. These Continuously Validated States are recorded on the Electronic Compatibility Matrix. The VxRail team's \$60 million in equipment investment with 100+ team members dedicated to testing and quality makes this possible.

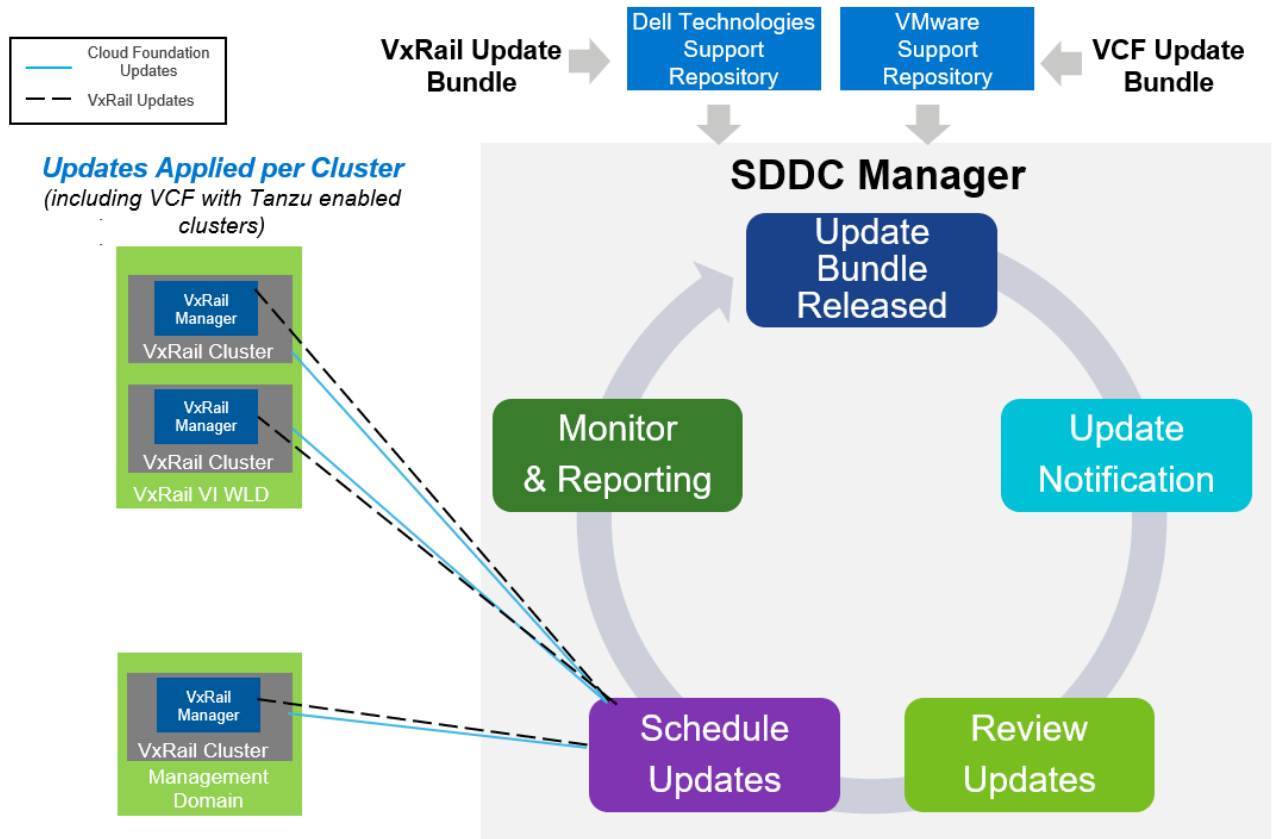
All VMware Cloud Foundation on VxRail lifecycle patching and upgrade operations are orchestrated using SDDC Manager. It is responsible for monitoring the respective VMware and Dell EMC support repositories where the VMware Cloud Foundation and VxRail update bundles get published. The VMware Cloud Foundation update bundle contains updates for vCenter, Platform Services Controller, NSX, SDDC Manager and vRealize Suite components (vRealize Automation, vRealize Operations and vRealize Log Insight). The native VxRail update bundle includes ESXi, vSAN, VxRail Manager, hardware firmware and drivers. As a part of this monitoring, SDDC Manager would automatically discover when new VxRail and VMware Cloud Foundation updates are available for download and proactively notify the administrator accordingly within the user interface.

SDDC Manager will also ensure that all update bundles are automatically curated, guaranteeing visibility and access to only the updates that have been qualified and supported for the system configuration it is managing. For example, an update cannot be accessed for a workload domain until first applied to the management domain. SDDC Manager even controls the ordering of LCM updates to ensure that a bundle version cannot be applied without first verifying that all update pre-requisites are met first. This helps mitigate risk so that the system is always at a known good state from one version to the next. This removes any need for the administrator to guess about valid releases or to cross reference support matrices to ensure update bundle compatibility across the system.

All updates are scheduled, executed, and orchestrated by SDDC Manager but may be executed by SDDC Manager or VxRail Manager using integrated APIs as shown in Figure 17.

Once a set of updates has been downloaded, SDDC Manager is used to schedule the updates to be applied to each of the workload domains in the environment independently.

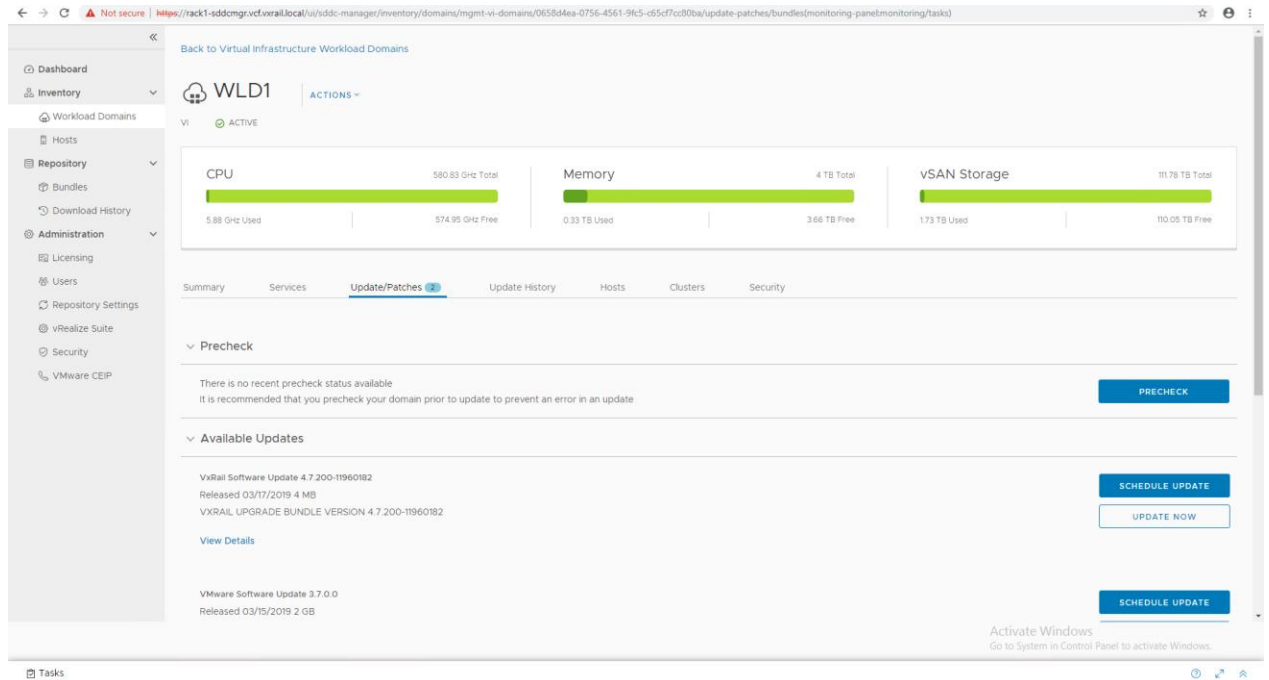
**Figure 17** SDDC Manager orchestrated lifecycle management integrated with VxRail



Lifecycle management in SDDC Manager can be applied to the Management Domain, which contains SDDC software stack or to individual workload domains and does not disrupt tenant virtual machines (VMs). Using live VM migration together with vSphere Dynamic Resource Scheduler (DRS), SDDC Manager can patch software to improve infrastructure security and reliability. VMware and Dell EMC do extensive validation testing of the software stack prior to releasing software updates, which reduces risk and helps to instill confidence.

The SDDC Manager Lifecycle Management view provides notification of update availability and download of the update bundle. The SDDC Manager interface also provides for selecting update targets and scheduling the update. It is highly recommended to schedule updates at a time when SDDC Manager is not in heavy use and avoid any changes to the domains being upgraded until after the upgrade completes.

Before starting the update, there are prerequisite tasks that ensure the system is in a healthy state. The pre-check utility can be manually triggered in the SDDC Manager Update/Patches screen as shown in Figure 18.

**Figure 18** SDDC Manager Update/Patches screen example

For native VMware Cloud Foundation software updates, SDDC Manager will execute the automated workflows needed to apply those updates to the clusters within a workload domain.

For native VxRail updates, SDDC Manager will orchestrate the LCM process for a given workload domain, but will leverage the native VxRail Manager that runs on each VxRail cluster in that workload domain to apply the VxRail update using integrated VxRail Manager REST API calls in the background. As VxRail Manager performs the cluster update, SDDC Manager will monitor its progress, and when completed will be notified by VxRail Manager of completion. In a multi-cluster workload domain example, this process of SDDC Manager automatically calling out a VxRail cluster's VxRail Manager API's occurs automatically without any administrator input until all clusters in the workload domain have been updated. Starting with VMware Cloud Foundation 4.0.1 on VxRail 7.0, customers can upgrade specific host clusters within a workload domain, which provides more flexibility in planning maintenance windows.

All of these co-engineered features are what drives the full stack integration lifecycle management experience only available with VMware Cloud Foundation on VxRail. A true better together experience to help Dell EMC customers simplify and accelerate their IT Transformation.

Hands on interactive click through demos for the LCM process and more, are available at [vxrail.is/vcfdemo](http://vxrail.is/vcfdemo).

## 1.9 External storage for VMware Cloud Foundation on VxRail

External storage can be used with VMware Cloud Foundation on VxRail (NFS/iSCSI/FC) to compliment primary vSAN storage for workload domain clusters. This is known as supplemental storage.

External secondary storage is primarily used for:

- Data protection (file/image backups)
- Data at rest (templates, backups, archives)
- Workload and data migrations to VMware Cloud Foundation on VxRail from legacy environments



- Storage for applications

Supporting external storage in VMware Cloud Foundation for VxRail is comparable to the experience of administrators using standard vSphere clusters who want to attach secondary datastores to those clusters. For VMware Cloud Foundation, this mounting process is performed manually using standard vCenter operations procedures. The platform does not take ownership of the life cycle management, storage provisioning, or network (IP or FC) configuration or zoning for the external storage systems. Instead, administrators use the native storage system and network management tools for those tasks.

## 1.10 VxRail flexible hardware configurations

VxRail nodes are available with different compute power, memory and cache configurations to closely match the requirements of new and expanding use cases. As requirements grow, the system easily scales out and scales up in granular increments.

Dell EMC delivers the #1 hyper-converged infrastructure portfolio purpose-built for HCI with the newest Dell EMC PowerEdge server platform. This portfolio delivers tailor-made performance and reliability powerful enough for any workload, combined with an advanced approach to intelligent deployment and operations that simplify and accelerates IT. Dell EMC HCI on next gen PowerEdge servers are powerful and purposeful and hyper-converged platforms that provide the ideal foundation for software-defined data center initiatives.

With up to 150 customer HCI requirements built-in, PowerEdge servers are designed specifically for and tailored to HCI workloads that depend on both servers and storage. This results in a more consistent, predictable and reliable high-performing HCI that can meet any use case. With a comprehensive portfolio, Dell EMC can deliver the best fit for organization specific HCI needs – from workload requirements, to customer environment/standardization, to deployment preferences.

Dell EMC leads in hyper-converged sales with over 30% market share according to IDC<sup>3</sup>. More customers are choosing Dell EMC HCI over all others. Dell EMC PowerEdge is the world's bestselling server. Industry-leading Dell EMC HCI built on industry-leading PowerEdge, coupled with a single point of support and full lifecycle management for the entire system, makes for a winning solution.

VxRail environments are configured as a cluster, with each node containing internal storage drives. VxRail systems are delivered with the software loaded, ready to attach to a customer-provided network. While most environments use 10Gb Ethernet for internal and external communications, 25Gb Ethernet connectivity is also available. Using a simple wizard at the time of install, the system can be configured to match unique site and networking requirements.

Dell EMC VxRail appliances offer a choice of Dell EMC PowerEdge servers, powered by new Intel® Scalable® processors, variable RAM and storage capacity, allowing customers to purchase what they need now. Single-node scaling and storage capacity expansion provide a predictable, “pay-as-you-grow” approach for future scale up and out as business and user requirements evolve.

Figure 19 shows the comprehensive set of options available across the family as of the writing of this paper. Customers can be assured their VxRail is configured to best match their workload requirements in a very prescriptive manner, with millions of possible configuration combinations in the VxRail model series family.

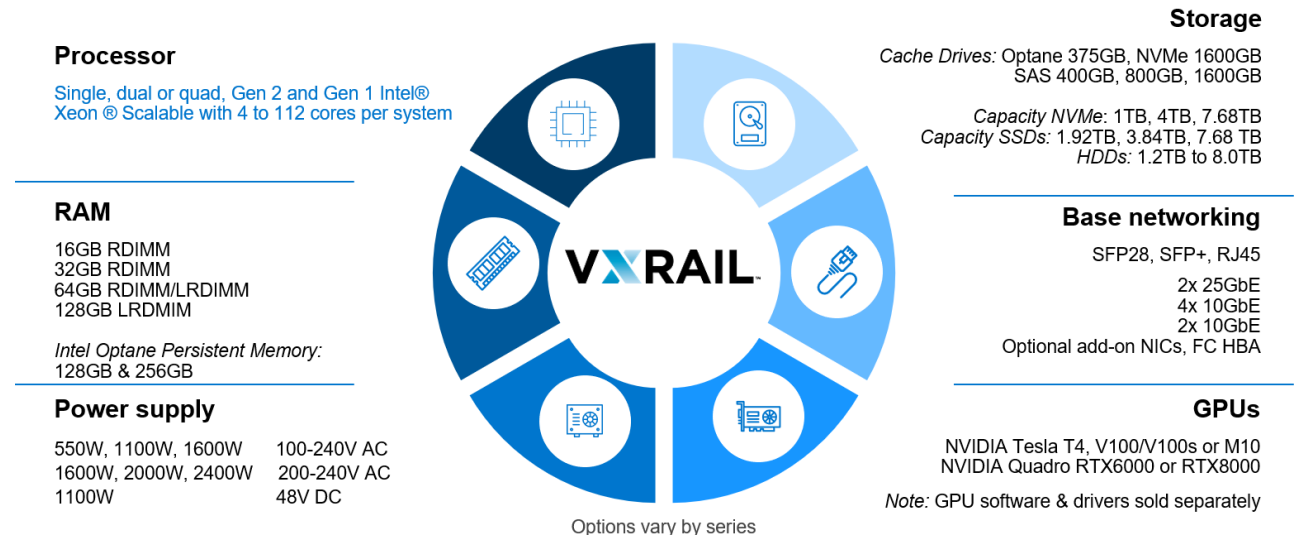
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<sup>3</sup> Based on IDC converged Tracker Q1 2018, June 2018

More information on VxRail hardware configurations is available in the Dell EMC VxRail Appliance TechBook<sup>4</sup>.

**Figure 19** Component options available across the VxRail Appliance.

E, P, V, D, S, G Series based on the latest Dell EMC PowerEdge servers



VxRail’s automated lifecycle management enables scale out where new appliances can be added non-disruptively and different models can be mixed within a VxRail cluster. By adding the latest technology appliances into existing clusters and decommissioning aging appliances, an evergreen HCI environment can be obtained; no need to worry about costly SAN data migrations ever again. Flexible storage options also allow a node to start with a few drives and add drives as capacity requirements grow. Appliances may also be scaled-up where the VxRail nodes can be non-disruptively upgraded with additional memory, GPU, NIC cards, cache SSD and capacity drives to meet changing requirements. Single-node scaling and expansion provide a predictable, “pay-as-you-grow” approach for future scale up and out as business and user requirements evolve.

## 1.11 VxRail delivery options

VMware Cloud Foundation on Dell EMC VxRail can be delivered as either a cluster of nodes (platform) that leverages the customer’s existing network infrastructure, or an integrated rack system with integrated networking as shown in Figure 20.

These delivery packaging options can be used for all different customer use cases – Standard VxRail HCI with vSAN, VCF on VxRail, VxRail edge, and Dell Technologies Cloud Portfolio offerings (VCF on VxRail and VMC on Dell EMC).

<sup>4</sup> <https://www.dellemc.com/resources/en-us/asset/technical-guides-support-information/products/converged-infrastructure/h15104-vxrail-appliance-techbook.pdf>



**Figure 20** VxRail delivery options

### 1.11.1 VxRail integrated rack delivery services options

For customers that would like to get their VCF on VxRail solution delivered as a rack integrated system, Dell EMC has available a set of rack assembly services that customers can purchase that leverage the power of the Dell 2nd Touch facility global footprint to incorporate additional factory services as part of VCF on VxRail delivered solution.

Dell Technologies offers two types of integration services – Fixed Configuration VxRail Integrated Rack Services Options or Flexible VxRail Integrated Rack Services Options. Depending on the VxRail solution use case, one or both integration services options may be available.

Customers who choose the VxRail nodes deployment option maintain the responsibility for defining the networking and rack configuration as well as performing the work of physically racking of the nodes, and non-Dell 3rd party products.

Customers who choose the VxRail Integrated Rack deployment option chose to have Dell Technologies to perform the physical rack and stack the VxRail nodes in a rack prior to delivery. This delivery option supports all of the available VxRail solution use cases.

Depending on which hardware configuration desires, customers can choose from a list of fixed rack design configurations that leverage Dell Technologies defined networking and rack components along with a subset of VxRail node configuration options. This option supports all of the available VxRail solution use cases.

If a customer desires a more flexible integrated rack configuration engagement in which they can define the networking and rack components as well as VxRail node hardware and rack design configuration, including the use of 3rd party products, then Flexible Rack Integration options are also available. Note: For 3rd party components, the customer will be responsible for procuring and sending the products to a Dell Technologies 2nd Touch Facility for racking. This option supports all of the available VxRail solution use cases.

Finally, for those who desire specific turnkey VxRail cloud solution outcomes and who value speed of delivery, customers can purchase one of the cloud solution offerings available within the Dell Technologies Cloud portfolio. These solutions are turnkey and are designed/packaged to provide the fastest time to value. They are delivered as Fixed Configuration VxRail Integrated Racks whose components and rack configuration design are predefined by Dell Technologies in order to optimize speed of delivery. For these solution offerings, customers will have a limited choice of fixed VxRail node configurations to pick from that will be pre-

racked as part of solution delivery. Available offerings in this category include VCF on VxRail and VMC on Dell EMC.

**Figure 21** Examples of VxRail integrated rack delivery options



#### Fixed Rack Design Configuration Factory Services delivery options

- Customers looking to adopt VCF on VxRail, Standard VxRail with vSAN, and Edge VxRail use cases
- No specific networking equipment vendor or model requirements

#### Flexible Rack Design Configuration Factory Service delivery options

- Customers looking to adopt any of the VxRail use cases but the design criteria available with fixed rack design configurations does not meet their requirements
- Require 3<sup>rd</sup> party networking hardware vendor equipment, or no networking at all
- Require 3<sup>rd</sup> party rack hardware

Note: All VCF on VxRail deployments require professional services to deploy, install, and configure the entire VCF on VxRail HW/SW stack at the customer site

### Rack Assembly Performed at 2<sup>nd</sup> Touch Facilities

Fully Flexible and Fixed Rack Configurations

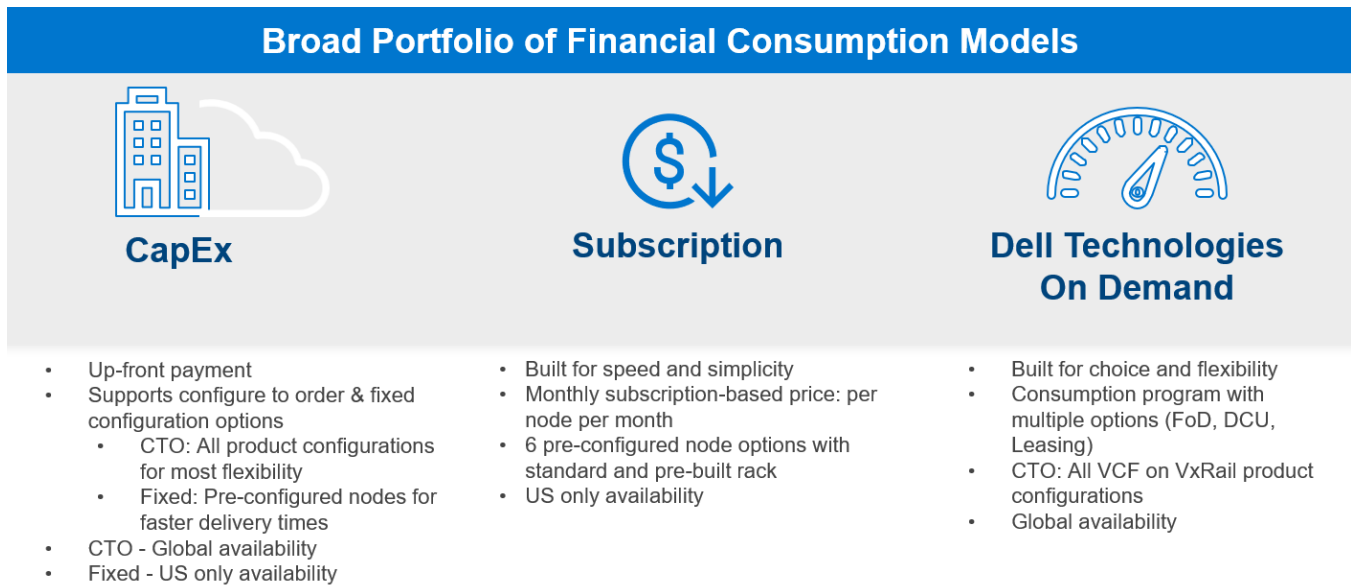
## 1.12 VMware Cloud Foundation on VxRail financial consumption models

VCF on VxRail offers flexible financial consumption models that can align to how customers choose to consume their private cloud technologies. They include traditional CAPEX, DTCP Subscription, and Dell Technologies On Demand.

- **CAPEX** - As has always been the case, customers can purchase VCF on VxRail using traditional CAPEX consumption models. This model requires an upfront payment. This option is available for two solution configuration options: Configure to Order and Fixed configurations. CTO configurations enable complete choice and flexibility. Fixed configurations include a subset of pre-configured node configuration options designed for faster delivery times. CTO configurations are available globally while fixed configuration options are available only in the US currently.
- **DTCP SUBSCRIPTION** - The Dell Technologies Cloud Platform with VCF on VxRail offers subscription pricing options. DTCP subscriptions are built for speed and flexibility. Released in February 2020 update of DTCP (VCF on VxRail), makes it very easy and quick for customers to buy and scale hybrid cloud deployments with a choice of 6 pre-configured node options with standard and pre-built racks. As a subscription, the monthly price is based on per node per month cost. This is another step on our path for cloud innovation, focusing on making it as simple as possible to do business with Dell Technologies. It is currently available in the US only.
- **Dell Technologies ON DEMAND** - With the recent expansion of Dell Technologies On Demand across the portfolio organizations are able to deploy Dell Technologies Cloud Platforms and pay only for the technology used, providing access to elastic capacity and payments that adjust up or down to match usage. This option is built for choice and flexibility. It is a consumption program that is made up

of different financial consumption models like Flex On Demand, Data Center Utility, and Leasing options. Dell Technologies On Demand offerings support the full configure to order configurations available with VCF on VxRail and is available globally.

**Figure 22** VMware Cloud Foundation on VxRail financial consumption options



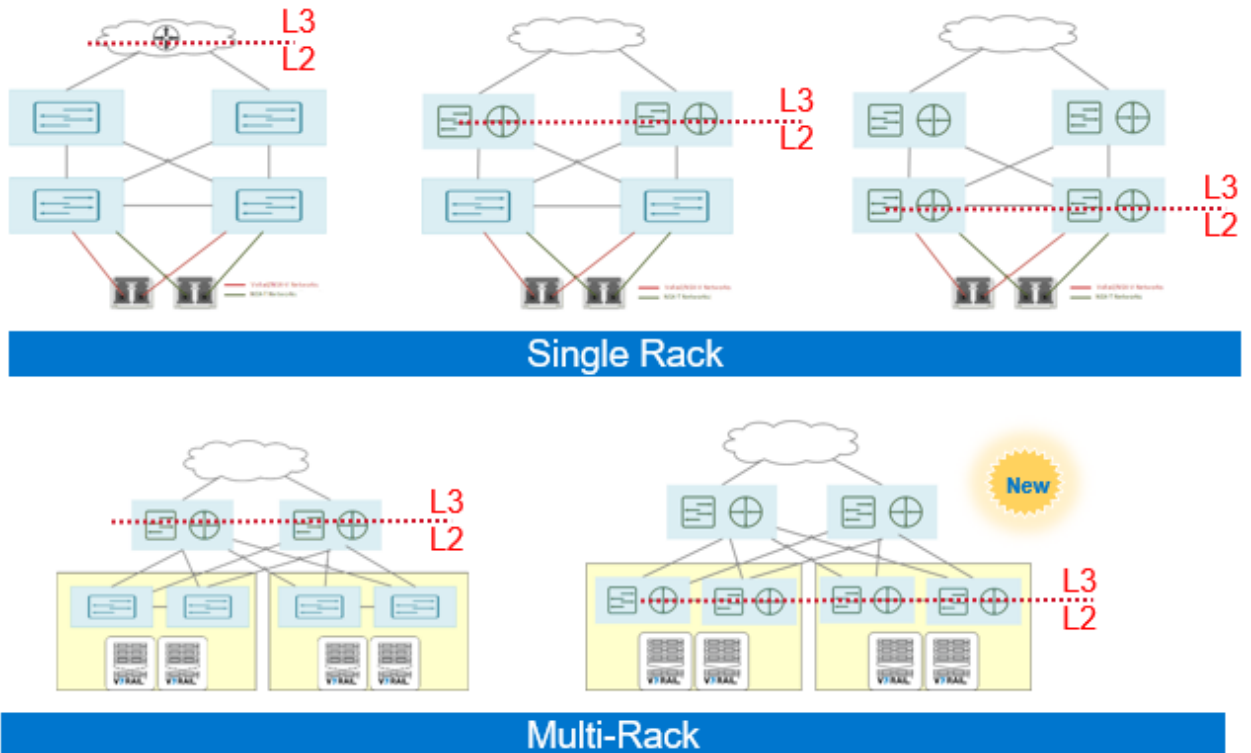
## 1.13 Networking

VMware Cloud Foundation supports a network flexible architecture. Customers can choose switches that meet their organization's standard and scalability requirements. There is also increased flexibility in network configurations permitting customers to configure VLANs and other settings without fear of disrupting SDDC Manager's automation or configuration. SDDC Manager does not require access to the physical network layer. Switches are manually configured by the customer's network team or by the professional services engineer, if this part of implementation is also covered with a custom services engagement.

There are multiple VMware Cloud Foundation on VxRail network topology options. The choice of topology design will depend on desired outcomes. The most common network topology for VMware Cloud Foundation on VxRail will follow a standard spine-leaf architecture. Decisions need to be made on where the VLANs from the platform's workload domains will terminate in the supporting physical network layer. Decisions must also be made for the layer 2/layer 3 boundary in multi-rack deployments of VMware Cloud Foundation on VxRail.

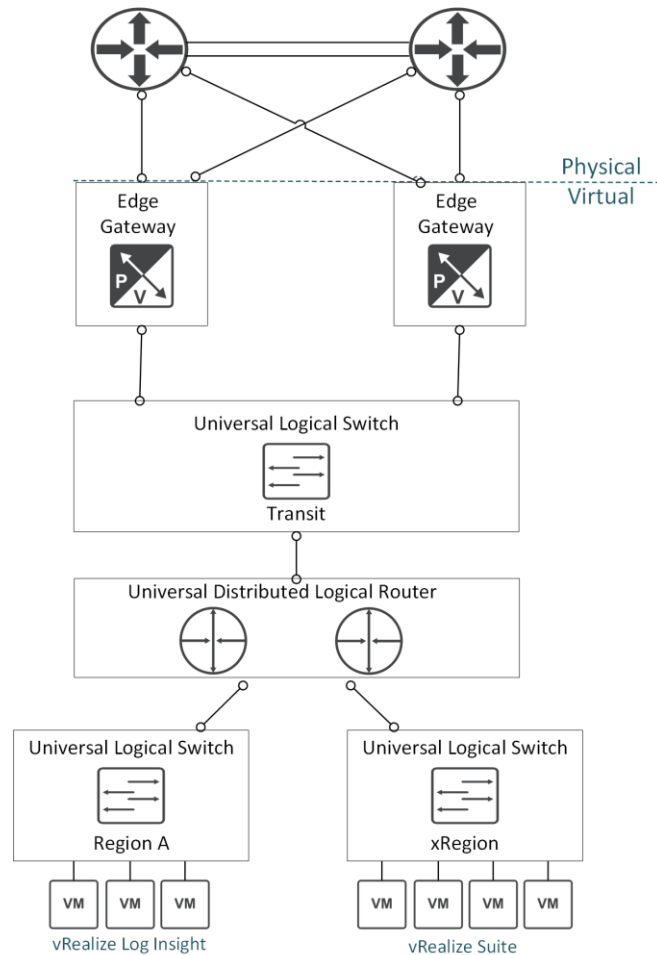
Some example physical network topology designs are shown in Figure 23. For more detailed documentation on network design options, please refer to the VxRail Network Planning Guide and Architecture Guides as well as Dell EMC Networking Guides on the VxRail Knowledge Center and Dell EMC support portal (links provided in the Appendix A – References).

**Figure 23** VMware Cloud Foundation on VxRail example network topology options



As of VxRail 4.7.300, VxRail node networks for a cluster spanning additional racks can share same IP subnet (non-routable) or assigned a different IP subnet (routable). This provides even more network configuration flexibility for customers.

With version 4.0 of the platform, VMware introduced the concept of Application Virtual Networks (AVN). The Application Virtual Network enables linkage for the vRealize Suite cloud management components and enables connectivity to the upstream external network. The vRealize components, including vRealize Log Insight, vRealize Life Cycle Manager, vRealize Operations Manager and vRealize Automation, connect to the AVN when deployed.

**Figure 24** Application Virtual Network (AVN) Overview

AVN provides the following benefits:

- The application virtual network is highly secured by using an NSX Edge device as the distributed firewall to isolate applications from each other and external users. Direct access to application virtual networks is controlled by distributed firewall rules;
- Prepares for future use of a single IP network address space that provide application mobility between data centers;
- Simplified future disaster recovery procedures
- Applications that need failover support across regions now have an overlay backed subnet that spans across regions;
- During failover, applications retain their IP addresses, resulting in faster RTO.

Note, that at the time of writing this document, dual-region configuration of VMware Cloud Foundation 4.x on VxRail 7.x with SRM-based disaster recovery is not supported yet.

### 1.13.1 Network Virtualization

The foundation of the network virtualization layer for VMware Cloud Foundation on VxRail is provided by NSX-T. NSX provides a software-defined networking approach that delivers Layer 2 to Layer 7 networking services (e.g., switching, routing, firewalling, and load balancing) in software. These services can then be programmatically assembled in any arbitrary combination, producing unique, isolated virtual networks in a matter of seconds. NSX-T, which is considered the next generation virtual network platform provides native support for Kubernetes, VMware Tanzu and cloud native applications.

To learn more about VMware Cloud Foundation on VxRail network architecture, including NSX-T, please consult *VMware Cloud Foundation on VxRail Architecture Guide* (link provided in the Appendix A – References).

## 1.14 Multi-site use cases

With flexible network architecture, VMware Cloud Foundation on VxRail systems can support multi-site use cases. Deployment in these cases is not automated. By leveraging additional guidance contained in the VMware Validated Designs, customers can deploy Cloud Foundation environments in multiple availability zones topologies to support variety of multi-site and stretched cluster use cases.

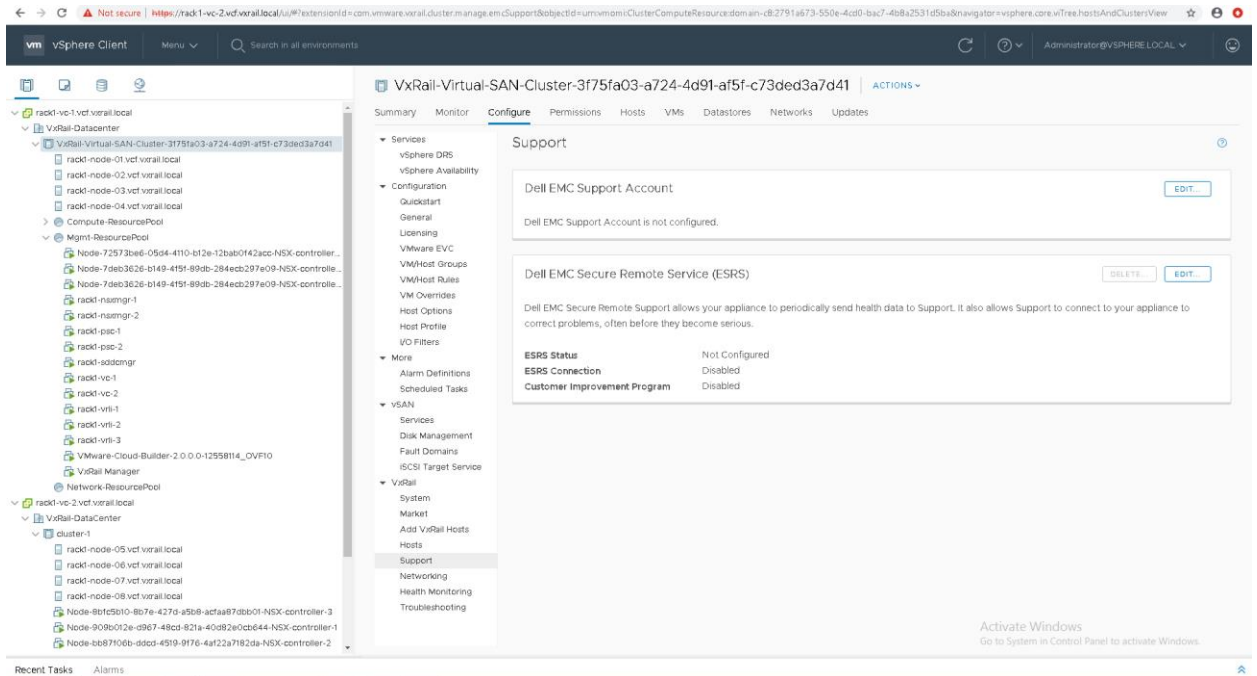
Availability zones enhance resiliency of the SDDC and improve SLAs by:

- Allowing identification of separate fault domains within the primary region.
- Leveraging the stretch-clustering capabilities of vSAN to distribute workloads across the availability zones.

## 1.15 Services and support

### 1.15.1 Accessing Dell EMC Support tab from vCenter

The Dell EMC Support tab is visible in vCenter with the VxRail Manager HTML5 vCenter plugin. The Support tab provides access to Dell EMC Services and Support information such as Dell EMC Software Remote Services (SRS) configuration information, along with online chat support service request administration capabilities. The Support tab also provides links to VxRail Community pages for Dell EMC Knowledgebase articles and user forums for FAQ content and VxRail best practices. Figure 25 shows an example of the support view.

**Figure 25** Dell EMC Support tab visible in vCenter with the VxRail Manager HTML5 vCenter plugin

### 1.15.2 Dell EMC Secure Remote Services (SRS)

Today's data centers are rapidly modernizing in technology, processes and workflows. With this continuous evolution, unplanned interruptions to data and applications can greatly hinder business outcomes. Many of these unexpected problems caused by issues such as failing drives or outdated code levels could have easily been avoided if they were detected earlier. As a foundational element of the Dell EMC Modern Customer Service Experience, Dell EMC Secure Remote Services (SRS) detects potential issues and proactively resolves them before there is any business impact.

For VMware Cloud Foundation on VxRail, the SRS extension:

- Coordinates VxRail system events and alerts for proactive call home support with Dell EMC support
- Reduces time to resolution and improves SLA uptime
- Integrates with Dell EMC automated dispatch support for parts replacement for server drives and power supplies

SRS is a highly secure remote connection between Dell EMC products, inclusive of VxRail, and Dell EMC Customer Support that helps avoid and resolve issues faster. SRS is completely virtual and offers flexibility for enterprise environments of any size. Available at no additional cost with an active ProSupport Enterprise or warranty contract, SRS unlocks a wide range of benefits and services, including:

- Proactive wellness monitoring and issue prevention
- Automated issue detection, notification and case creation for quicker uptime
- Predictive, analytics-based recommendations

The SRS lifeline is a heartbeat that pulses outbound in 30-second intervals from the SRS gateway to Dell EMC Customer Service, providing Dell EMC with connectivity status as well as the status of each product. The heartbeat ensures continuous monitoring, notification, and, if necessary, proactive remote troubleshooting to ensure high availability of Dell EMC products.



The security of customer data is Dell EMC's top priority. From collection to transport to storage, SRS employs multiple security layers throughout each step in the remote connectivity process to ensure that both customers and Dell EMC can use the solution with confidence:

- SRS software distributed to customer site using FIPS 140-2 validated cryptography
- All notifications to Dell EMC originate from the customer site—never from an outside source—and are kept secure using Advanced Encryption Standard (AES) 256-bit encryption
- IP-based architecture integrates with the customer's existing infrastructure and maintains a secure environment
- Communications between the customer site and Dell EMC are bilaterally authenticated using RSA® digital certificates
- Only authorized Dell EMC Customer Service professionals verified via two-factor authentication can download the digital certificates needed to view a notification from the customer site
- Remote Service Credentials means there are no shared login credentials between Dell EMC technicians, and no single static login to a customer's system
- The optional SRS Policy Manager application enables customers to grant or restrict access based on customer-specific guidelines and requirements, and includes a detailed audit log.

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**Note:** the trusted and secure SRS secure remote connection is leveraged to support data transfer for other VxRail services such as the SaaS multi-cluster management.

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### 1.15.3 Dell EMC eServices support community and knowledge base integration

Once a customer registers a VMware Cloud Foundation on VxRail platform for a Dell EMC support account, it provides access to Dell EMC support account eServices features including:

- KB article search
- In context ability to open support tickets with pre-populated customer data filled into the ticket
- Chat session with support
- Dell EMC Community Network access

Native VxRail integration with Dell EMC backend support services are built into vCenter through the VxRail Manager vCenter plugin.

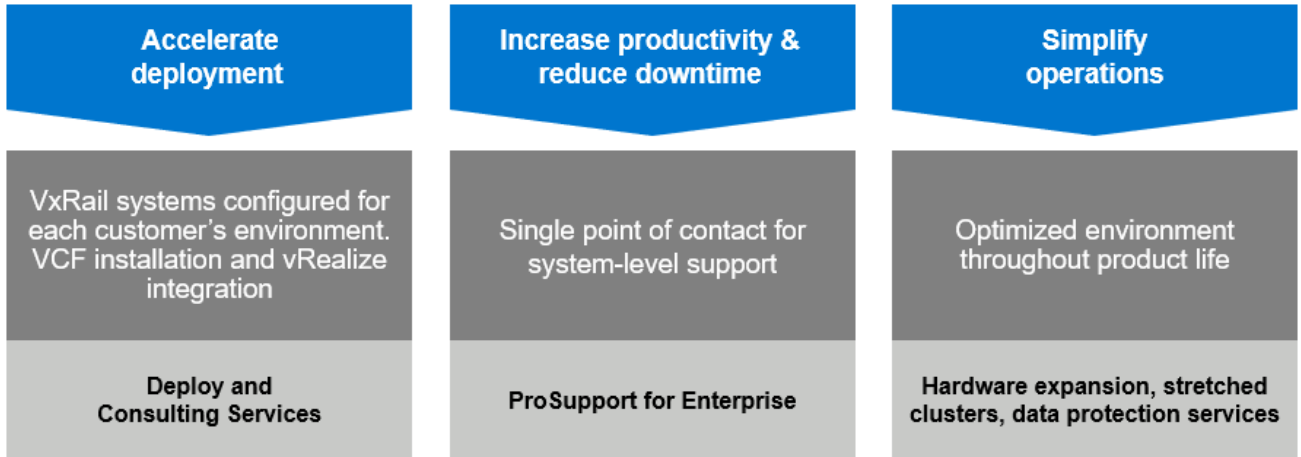
### 1.15.4 Dell EMC Professional Services

Dell EMC Services must be used to successfully install VxRail and the VMware Cloud Foundation software platform. Dell EMC networking hardware installation and multi-site or stretched cluster configuration initial installation are also optionally available services. Any day 2 customization work (for example NSX customization, vRealize Automation customization, data protection customization) that is needed would be performed using additional services engagements with VMware or Dell EMC

Dell EMC Services accelerates the deployment, reduce downtime and simplify operations of VMware Cloud Foundation on VxRail with a full range of integration, implementation, support and consulting services. Dell EMC Services helps IT organizations quickly realize the value of their investment both by deploying the hardware and software components of VMware Cloud Foundation on VxRail, as well as achieving IaaS through integration of this integrated cloud platform into their application portfolio, operating model and enterprise infrastructure.



**Figure 26** Dell EMC Services for VCF on VxRail



Consulting services complement the platform integration with services to hasten realization of IaaS:

- For application integration, target applications are profiled to determine their suitability and priority for VMware Cloud Foundation on VxRail deployment, and then assistance is provided to migrate these applications while minimizing downtime and risk.
- For operating model integration, help is provided to refine operational processes for more automated and agile-as-a-service operations, while also optimizing the roles and skills of customer teams for service-based operations.

### 1.15.5 Dell EMC support

Customers have a choice of support and maintenance options that can align to their business model as shown in Figure 27.

**Figure 27** VMware Cloud Foundation on VxRail support options

ProSupport	ProSupport Plus
<ul style="list-style-type: none"> <li>• 24X7 remote technical support</li> <li>• Onsite hardware support: next business day or 4hr mission-critical</li> <li>• 3<sup>rd</sup> party collaborative assistance</li> <li>• Automated issue detection and proactive case creation</li> <li>• Self-service case initiation and management</li> <li>• Access to software updates</li> <li>• Support for VCF software</li> <li>• System software code upgrades for VCF on VxRail*</li> </ul>	<p><b>All the features of ProSupport, as well as:</b></p> <ul style="list-style-type: none"> <li>• Priority access to specialized support experts</li> <li>• Eligible 3<sup>rd</sup> party software support</li> <li>• Assigned Technology Services Manager</li> <li>• Personalized assessments and recommendations</li> <li>• Semiannual systems maintenance</li> </ul>

Customers that purchase all components from Dell EMC get a single vendor support experience from Dell EMC. For VMware Cloud Foundation software, Dell EMC provides the initial support levels and coordinates advanced level support from VMware. Similarly, for Dell supplied APC Racks, Dell EMC provides the initial support and engages advanced support from APC.

Exclusively for VCF on VxRail, Dell Technologies offers single source of support for VCF software on both ProSupport and ProSupport Plus even if customer brings their own VCF licenses.

Additionally, remote system software code upgrades performed by Dell EMC are included in both ProSupport and ProSupport plus.

Even though customers can choose to do their own VCF system software code upgrades, they also have the option to have code upgrades performed by the Dell Technologies Remote Proactive Team as long as they have an active ProSupport Suite for VCF on VxRail contract (ProSupport, ProSupport Plus or ProSupport One – Next Business Day or 4 hour Mission Critical). This simplifies their overall full stack support experience.

Customers purchasing Network Switches or Rack/PDUs from third parties, will get support for those components from the third-party vendor.

Dell EMC ProSupport Plus offers a single source with the expertise, know-how and capabilities to deliver world-class support.

ProSupport Plus offers highly trained experts around the clock and around the globe to address IT needs, minimize disruptions and maintain a high level of productivity. With over 55,000 Dell EMC and partner professionals across 165 countries speaking more than 55 languages, Dell enables businesses to:

- Maximize productivity by leveraging Dell EMC scale and skill
- Minimize disruptions with around the clock access to highly trained experts
- Gain efficiency through a single source for all support needs

Single source, 24x7 global support is provided for VxRail appliance hardware and software (including VMware Cloud Foundation software) via phone, chat, or instant message. Support also includes access to online support tools and documentation, rapid on-site parts delivery and replacement, access to new software versions, assistance with operating environment updates, and remote monitoring, diagnostics and repair with Dell EMC Secure Remote Services (SRS).

Dell EMC's 12 Centers of Excellence and Joint Solution Centers deliver in-house collaboration and industry-leading levels of support, leveraging Dell EMC's alliances with leading application providers such as Oracle and Microsoft. Dell EMC's 87 technical support sites are comprised of 71 Dell Tech Support Sites and 16 Dell EMC Customer Service Centers.

## 2 Conclusion

VMware Cloud Foundation on VxRail provides the simplest path to the hybrid cloud through a fully integrated platform that leverages native VxRail hardware and software capabilities and other VxRail unique integrations.

Dell EMC helps organizations with their IT Transformation and adoption of hybrid cloud by providing flexible modern cloud infrastructure solutions that can seamlessly and simply transform at the pace they are ready for. IT Transformation is a journey that does not happen overnight. Dell Technologies is looking to become businesses' strategic partner to help them on their journey.

Dell EMC believes IT Transformation can be accomplished by adopting a MAT strategy, which takes advantage of the benefits that a hybrid can deliver. In MAT, businesses:

- **Modernize** their infrastructure, taking advantage of scale-out, software-defined and cloud-enabled technologies across servers, storage, and converged systems.
- **Automate** their services and create a new self-service experience for the business to interface with IT.
- **Transform** the way they operate, recognizing the need for new roles, skills, and organizational structures in order to leverage and optimize these new technology capabilities.

Businesses that can successfully navigate the MAT strategy are poised for success in the Digital Era. Customers who are just getting started, can look to modernize their traditional 3-tiered infrastructure by adopting hyper-converged infrastructure to help simplify compute and storage operations. Instead of managing compute and storage in silos and using hardware-based infrastructure to provide compute and storage services, customers can simplify their operations by consolidating compute and storage management using native VMware tools and leverage the power of automation and compute and storage virtualization to provide IT with more agility in provisioning infrastructure and lifecycle management. Instead of taking days to weeks to provision compute and storage infrastructure, this can now be done in minutes to hours. These capabilities can be introduced by deploying VxRail hyper-converged infrastructure. VxRail comes included with vSphere for compute virtualization, vSAN for storage virtualization, and VxRail HCI System Software, which includes VxRail Manager software for HCI lifecycle management. This stage can address the Modernize portion of the MAT strategy.

Customers who have a desire to virtualize all of their infrastructure and deploy a full VMware SDDC with the benefit of automated SDDC Lifecycle Management can start with implementing a standardized VMware SDDC architecture on VxRail with VMware Cloud Foundation that includes NSX for Network Virtualization and Security, vSAN for SDS, vSphere for SDC and SDDC Manager for SDDC lifecycle management. By virtualizing all of their infrastructure, customers can take advantage of what a fully virtualized infrastructure can provide such as resource utilization, workload and infrastructure configuration agility, and advanced security. SDDC software lifecycle automation, provided by VMware Cloud Foundation (and in particular SDDC Manager which is a part of the platform) customers can streamline the lifecycle management experience for the full SDDC software and hardware stack. They no longer need to worry about performing updates and upgrades manually using multiple tools for all of the SDDC software and hardware components of the stack. These processes will now be streamlined using a common management toolset in SDDC Manager in conjunction with VxRail Manager. At this stage, customers can begin to leverage the data services benefits that a full virtualized infrastructure can offer along with SDDC infrastructure automated LCM. An example of some of the data services would be using Software Defined Networking features from NSX like micro-segmentation, which before software defined networking tools, would be nearly impossible to implement using physical networking tools. The other important aspect here is the introduction of a standardized architecture for how these SDDC components are deployed together by the introduction of

VMware Cloud Foundation, an integrated cloud software platform. Having a standardized design incorporated as part of the platform provides customers with a guarantee that these components have been certified with each other and has the backing of Dell Technologies. Customers can then be assured, there is an automated and validated path forward to get from one Continuously Validated State to the next across the end to end stack. Customers also have the optional flexibility to incorporate Virtual Desktop and Cloud Native Platform with modern app services use cases, with Horizon and VCF with Tanzu respectively, that can run on this fully virtualized infrastructure. This stage can be used to address the Modernize and Automate portion of the MAT strategy and can also become the foundation for a customer to be able to seamlessly implement a full-blown hybrid cloud in the future.

As IT's readiness grows, they may have needs for better operational management of this newly totally virtualized infrastructure. Here they can incorporate additional SDDC operations management services capabilities into their SDDC. These operations management capabilities, provided by vRealize Operations and vRealize Log Insight and vRealize Network Insight, can seamlessly be added in alignment with best practices standardized architecture guarantees. In this stage, customers can begin transforming how they operate to better manage and monitor a fully virtualized infrastructure. Customers now can gain more insight into the SDDC abstractions that exist across compute, network, and storage. They can leverage the power of built in analytics to become smarter and more efficient when performing capacity planning or troubleshooting. This stage can begin to address the Modernize and Automate portion of the MAT strategy.

Once IT has a comfort level in managing, operating, and automating a fully virtualized SDDC infrastructure, they may be ready to fully transform how they deliver this infrastructure to the business by adopting a cloud operating model and thus providing the business with services such as Infrastructure as a Service and Desktop as a Service etc. using IT provided self-service portals and catalogs to business users. This stage in the MAT strategy would involve a combination of people and process changes within an IT organization as well as technology to support it. Here, IT organizations can introduce cloud management with vRealize Automation, and cloud costing with vRealize Business. At this stage, IT would have a full private cloud and would be addressing the Transform stage of the MAT strategy.

For many customers, the final destination they want to achieve is a hybrid cloud. In this stage, customers extend on the capabilities they've built up with their private cloud and begin to incorporate public cloud services to enable workload mobility and location independence for deciding where workloads should run, all while leveraging a common operating model across both private and public cloud resources. Here customers can leverage public cloud services such as VMware Cloud on AWS, or other consumption models, such as VMware Cloud on Dell EMC, to align to business priorities whether it be for cost purposes or governance requirements. It allows IT to be a strategic business enabler for new Digital Transformation initiatives.

In summary, VMware Cloud Foundation on VxRail makes operating the data center fundamentally simpler by bringing the ease and automation of the public cloud in-house by deploying a standardized and validated network flexible architecture with built in lifecycle automation for the entire cloud infrastructure stack including hardware. It enables a true hybrid cloud based on a common and compatible VMware Cloud Foundation platform that stretches from on premises to off premises. The platform combines the speed and flexibility of public cloud with the security and control of on-premises infrastructure, providing simplicity, consistency and peace-of-mind that empowers organizations to deliver business innovation and differentiation.

# A References

- Dell EMC VxRail  
<https://www.dell.com/en-us/converged-infrastructure/vxrail/index.htm>
- VMware Cloud Foundation on VxRail Architecture Guide  
<https://infohub.delltechnologies.com/section-assets/vmware-cloud-foundation-on-vxrail-architecture-guide>
- VMware Cloud Foundation on VxRail Planning and Preparation Guide  
<https://infohub.delltechnologies.com/section-assets/vmware-cloud-foundation-on-vxrail-planning-and-preparation-guide>
- Dell EMC VxRail Network Planning Guide  
<https://infohub.delltechnologies.com/t/planning-guide-dell-emc-vxrail-network-planning/>
- Dell EMC Networking Guides for VxRail  
<https://infohub.delltechnologies.com/t/guides-80/>
- Dell EMC VxRail Appliance TechBook  
<https://infohub.delltechnologies.com/t/techbook-dell-emc-vxrail-system-2/>
- VMware Cloud Foundation  
<https://www.vmware.com/products/cloud-foundation.html>  
<https://docs.vmware.com/en/VMware-Cloud-Foundation/>
- VMware Software-Defined Data Center (SDDC)  
<https://www.vmware.com/solutions/software-defined-datacenter.html>
- VMware vRealize Suite  
<https://www.vmware.com/products/vrealize-suite.html>  
<https://docs.vmware.com/en/vRealize-Suite/index.html>
- Dell EMC HCI for Kubernetes  
<https://www.dell.com/en-us/cloud/hybrid-cloud-computing/hci-for-kubernetes.htm>
- Dell Technologies Cloud Platform  
<https://www.delltechnologies.com/en-us/cloud/platforms/dell-technologies-cloud-platform.htm>
- VMware Cloud on Dell EMC  
<https://www.dell.com/en-us/solutions/cloud/vmware-cloud-on-dell.com.htm>

## B Business IT challenges and trends

### B.1 Business IT challenges

Technology is transforming the way we live and work at an ever-increasing pace. This is a new digital era. It is the dawn of the Internet of Things (IOT), what many have called the next industrial revolution. While previous industrial eras were driven by steam, coal and electricity, this one is driven by data. It is ruthlessly changing the business landscape and reinventing our future.

Business Information Technology (IT) departments are under significant pressure. IT is no longer just responsible for keeping the lights-on and treated as a cost center. IT is becoming a business partner, responsible for playing a significant role in digital transformation.

Digital transformation has become a rallying cry for every industry. As more of our daily lives and business opportunity shifts into the digital world, there is a corresponding need to prioritize IT activities within an organization. This shift has been very disruptive for organizations as existing systems, and operational models failed to adapt quickly enough to meet business needs, leading to cloud and shadow IT becoming a lightning rod of innovation that happened outside the watchful eye of central IT management. As this model has proven fruitful, organizations are looking to tap into that innovation in a more sustainable way.

There is an imperative to deliver new modernized applications to market, to innovate with technology to beat competitors and to do it faster with more choice. At the same time there are requirements for stricter compliance, improved security, controlled costs and increased efficiency. Lowering risk with disaster recovery (DR) and business continuity (BC) solutions becomes even more critical.

Traditional IT infrastructure is custom designed to fit a business' particular needs using any solution from any vendor. This flexibility comes with drawbacks, including the extensive time needed to research and get the initial or expanded infrastructure ordered, installed, and ready to deploy applications. Infrastructure from multiple hardware and software vendors leads to separately managed operational silos, relying on multiple IT staff with different areas of expertise. Without centralized management, achieving security and compliance is much more difficult. When there is a problem, support issues may get stuck in circular finger pointing where vendors blame one another. Even with careful planning, upgrades run into complications and increased risk from interactions between products from different vendors.

Each product in this type of legacy stack is likely to be grossly overprovisioned, using its own resources (CPU, memory and storage) to address the intermittent peak workloads of resident applications. The value of a single shared resource pool, offered by server virtualization, is still generally limited to the server layer. All other components, such as networks and storage, are islands of overprovisioned resources that are often not shared. Therefore, low utilization of the overall stack results in the ripple effects of high acquisition, space and power costs. Too many resources are wasted in traditional legacy environments.

The physical infrastructure consists of complex hardware silos that are difficult to manage or automate. Regular maintenance tasks and hardware outages require expensive downtime. Mitigating the problem using dedicated standby hardware is expensive. The hardware-centric architecture results in operational inefficiencies because of factors such as the limited capacity of the CPUs in running applications, a single operating system image per machine and inflexible infrastructure that is difficult to troubleshoot.

These problems can be mitigated by trading off a highly flexible choice of vendors and applications for building the infrastructure with a more standardized infrastructure that is easier to support and maintain. Traditional IT can use product compatibility lists to help alleviate multi-vendor support issues by reducing the

scope of solutions that can be considered for use to products included in the compatibility list. However, without easy automation solutions and with limited IT staff, achieving compliance is still very challenging.

## B.2 Trend to converged and hyper-converged infrastructures

Both converged and hyper-converged infrastructures help IT organizations standardize on the choice of multi-vendor products, reducing the time, cost and risk of deploying, configuring and managing hardware and software components separately.

Converged infrastructure (CI) is largely systems integration, where an entire solution is built and sold as a single pre-validated and qualified unit.

CI systems take the responsibility of system integration and validation of infrastructure components off the hands of customers and assure lifecycle management. Customers can spin up virtual machines, containers and even bare metal servers without having to worry about selecting, integrating or upgrading the infrastructure. A custom management interface and a combination of professional services for setup and upgrades shortens the time to get the solution running.

Hyper-converged infrastructure (HCI) uses software-defined technologies to provide compute, storage, and networking infrastructure services rather than using traditional purpose-built hardware components. HCI software defines the storage that is installed inside individual servers into a single, shared pool of storage and then runs workloads on those same servers. HCI is usually deployed on standard server components; providing a simplified scale-out architecture with intelligence and rich data services moved to the software layer. With a much narrower set of potential hardware and software combinations, HCI vendors more thoroughly test their hardware and software stack, providing easier software and hardware upgrades.

Organizations are transforming from traditional do-it-yourself infrastructure to adopting CI and HCI solutions to help them meet their business IT challenges. With CI and HCI infrastructures, multiple pre-engineered and pre-integrated components operate under a single controlled architecture with a single point-of-management and a single source for end-to-end support. HCI provides a localized single resource pool that enables a higher overall resource utilization than can be achieved with legacy infrastructure. Overall total cost of ownership (TCO) is lower with operational savings from simplified management. In the data center, HCI typically has a smaller footprint with less cabling and can be deployed much faster and at lower total cost than traditional infrastructure.

Industry infrastructure deployment is transforming as customers begin to shift from a “build” to a “consume” approach. This deployment shift is being driven by the need for IT to focus limited economic and human capital resources on driving business innovation, which results in fewer resources available to focus on infrastructure. While a “build-your-own” deployment strategy can achieve a productive IT infrastructure, this strategy can be difficult and lengthy to implement, vulnerable to higher operating costs and susceptible to greater risk related to component integration, configuration, qualification, compliance and management. A “consume” deployment strategy for HCI provides the benefits of previously integrated, configured, qualified and compliant components. Purchasing an HCI system provides a single optimized IT solution that is quick and easy to deploy. A “consume” deployment strategy for HCI provides a simple and effective alternative to “build-your-own” and it has been widely adopted.

## B.3 Trend to virtualization and software-defined infrastructures

Virtualization transforms physical systems into a virtual environment by creating a logical version of a device or resource - anything from a server to an operating system. Virtualization helps solve problems with



utilization and rapid scalability. Without virtualization, traditional server utilization is typically in only the 6% to 12% range.

Traditional hardware comes in fixed sizes and is hard to scale and fully utilize. Virtualization allows organizations to purchase more powerful equipment with better performance and put many optimally-sized virtualized resources on it. Technologies such as overprovisioning, automatic load balancing, clustering and parallel processing optimize resources and improve uptime. Virtualization technology emulates hardware using software that hides details of the underlying physical hardware. Multiple hardware components and the functionality of that hardware can be efficiently emulated on less expensive, non-specialized hardware.

Server virtualization is mature and proven technology with high adoption rates in data centers of all sizes. Both storage and network virtualization are growing trends. Storage virtualization groups physical storage from multiple storage devices so that it looks like a single storage device. Software-defined storage (SDS) includes storage virtualization and goes further to abstract all storage services from hardware devices using software to create, deploy and manage storage resources and infrastructure. SDS enables expensive proprietary storage solutions to be replaced with software-defined storage that utilizes x86 technology. By utilizing industry-standard x86 technology, SDS helps eliminate the need for storage area networks (SANs) and proprietary storage expertise. Organizations can also reduce their storage footprint, which lowers hosting and cooling costs

Software-defined networking (SDN) is a computer networking architecture that separates the data plane from the control plane in routers and switches. The control plane is implemented in servers using software and is separate from networking hardware. The data plane is implemented in networking hardware. In traditional networking, when a data packet arrives at a switch or router, the firmware tells the hardware where to forward the packet and sends all packets to that destination via the same path. All packets are treated the same. More advanced smart switches equipped with application-specific integrated circuits (ASICs) recognize different types of packets and treat them differently based on the ASIC programming. These switches, however, are expensive.

SDN decouples networking control from the hardware's firmware. The network administrator can centrally configure network traffic without changing the settings of individual switches. The administrator can change network rules, prioritization and selectively block packets with greater control. SDN provides better control of network traffic and offer better security options while using less expensive commodity switches as the underlying hardware layer.

### B.3.1 Software-defined data center (SDDC) solution

Combining server, storage and network virtualization together leads to a completely software-defined infrastructure. *The Why, the What and the How of the Software-Defined Data Center* (Osterman Research, May 2017) identifies the business benefits of the SDDC solution:

- **Improved speed and productivity of IT staff**  
Because of its software-defined nature, with proper tools, an SDDC is easier to configure, reconfigure and keep secure, resulting in IT operations that are more responsive to change and more efficient. SDDC also permits frequent service updates and rapid standup/teardown of test environments.
- **Improved security**  
SDDC's software-defined nature enables consistently enforced policies that act on logical, abstracted characteristics of the workload and its data. Traditional data center operations must distribute rules across a range of different hardware devices that will need to be manually updated with inevitable

hardware and configuration changes. In an SDDC, relevant policies remain in place and automatically adjust to changes in the underlying physical environment of SDDC workloads.

- **Improved reliability**  
Traditional IT operations are inherently error-prone, even when using a centralized management console. SDDC's ability to automate operations reduces repetitive tedium and error, which in turn maximizes security and minimizes unplanned downtime.
- **Improved utilization of hardware**  
Virtualization increases the hardware utilization, allowing organizations to make more efficient use of their capital expenditures. For example, it allows several workloads to share software-defined computing, storage and network resources. SDDC unifies networking functions using non-specialized hardware avoiding lock-in to specific networking equipment.
- **It enables an interoperable cloud**  
SDDC helps organizations realize the benefits of hybrid clouds without vendor or technology lock-in. The combination of automation, abstraction, visibility and control fosters consistency that will ease the placing of workloads into public or private clouds to an even greater extent than virtualization alone would permit.

## B.4 Trend to public and hybrid cloud

The ability of cloud computing to offer solutions to the business IT challenges stated above is driving more organizations to use cloud computing as a key part of their IT infrastructure.

The National Institute of Standards and Technology (NIST) provides a definition of cloud computing.

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.<sup>5</sup>

The five essential characteristics of cloud computing are:

1. On-demand self-service
2. Broad network access
3. Resource pooling
4. Rapid elasticity
5. Measured service

A public cloud is formed when a cloud provider makes computing resources publicly available over the internet or other broad network channels. In a public cloud, setup for a consumer is usually quick and easy. Users pay for resources used rather than for direct hardware. Some providers also charge a subscription fee. If more resources are needed, the cloud can instantly provide them. There is no need to install additional

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<sup>5</sup> <https://csrc.nist.gov/publications/detail/sp/800-145/final>

hardware or software. One of the concerns and barriers for organizations using the public cloud is data security and governance.

Private cloud describes a computing infrastructure privately held by an organization that has capabilities similar to a public cloud but is completely internal and therefore could be considered more secure based on an organization’s regulatory and compliance requirements. Virtualization provides many cloud-like resource allocation features. The addition of cloud management tools can be used to build a private cloud.

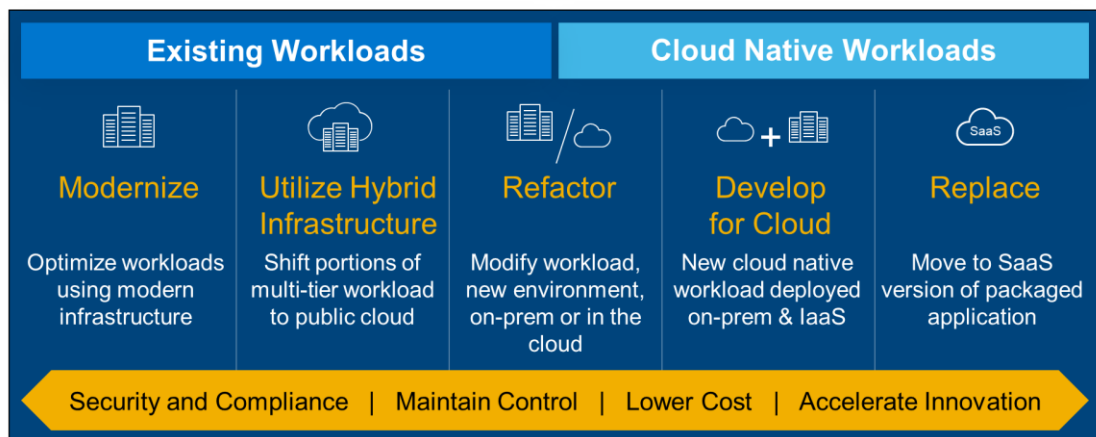
Almost every study shows that organizations desire to use a variety of cloud platforms across both public and private clouds resulting in a potentially complex multi-cloud strategy. As Jeff Clarke, vice chairman of products and operations of Dell Technologies, put it: “Cloud is not a destination; it’s an operating model.”<sup>6</sup>

## B.5 Trend from legacy to modern applications and multi-cloud

All IT departments must manage their application portfolio. That portfolio is typically split into two categories: existing applications and new applications. For existing applications, customers are wrestling with managing costs and maintaining a reliable, secure environment that will keep an existing portfolio of applications extended through its logical lifespan. They are also thinking about how they can add new capabilities and features to enhance and extend the value of existing applications. At the same time, they are prioritizing new built-in-the-cloud applications focused on differentiating their business from their competition.

As they wrestle with this dual portfolio, customers have a number of choices they can make about how to support legacy applications as shown in Figure 28. They can choose to maintain applications unchanged, but in an increasingly virtualized and enhanced environment. They can also choose to move applications to the cloud and re-platform, hopefully with as little cost or effort as possible. They can refactor or rebuild applications for the cloud, build brand new apps in the cloud or replace them with a set of SaaS applications. Each of these decisions are based on business priorities and this is driving cloud adoption and strategies.

**Figure 28** Matching cloud strategies to the needs of each workload



<sup>6</sup> <https://www.livemint.com/technology/tech-news/why-michael-dell-is-betting-big-on-multi-cloud-strategy-1556592666769.html>

For many organizations, this increasingly diverse application landscape is resulting in an enormous amount of IT complexity. The main driver is due to the fact that over 93% of organizations are deploying their workloads across two or more clouds<sup>7</sup>. This multi-cloud approach grows increasingly complex due to multiple operational silos, resulting from disparate management and operations tools, increasingly complex application and infrastructure lifecycle management, ultimately delivering inconsistent service level agreements (SLAs). Solving this complexity is one of the biggest IT challenges.

Customer workload needs are changing, sometimes wanting to extend things out to a public cloud, and at other times wanting to bring things back on-premises. Almost every study shows that organizations desire to use a variety of cloud platforms across both public and private clouds. When ESG surveyed CIOs, 91% of respondents reported that their company's cloud strategy would include on-premises data centers where many have found some workloads realize 2-4x savings versus the public cloud alone.

There is a desire to future proof cloud decisions and provide flexibility through a hybrid cloud strategy. However, to do so effectively, customers must simplify the multi-cloud complexity challenge. Customers value a hybrid cloud strategy, which addresses the biggest issue regarding extension across on-premises and off-premises, with 83% of customers stating that they value consistency of infrastructure from data center to cloud<sup>8</sup>.

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<sup>7</sup> IDC White Paper, sponsored by Cisco, Adopting Multicloud — A Fact-Based Blueprint for Reducing Enterprise Business Risks, June 2018.

<sup>8</sup> VMware Cloud Market Study, January 2018

## C VMware software-defined data center (SDDC)

VMware is a leader in providing both the virtualization and management products that support a software-defined data center and in integrating them into a cohesive solution.

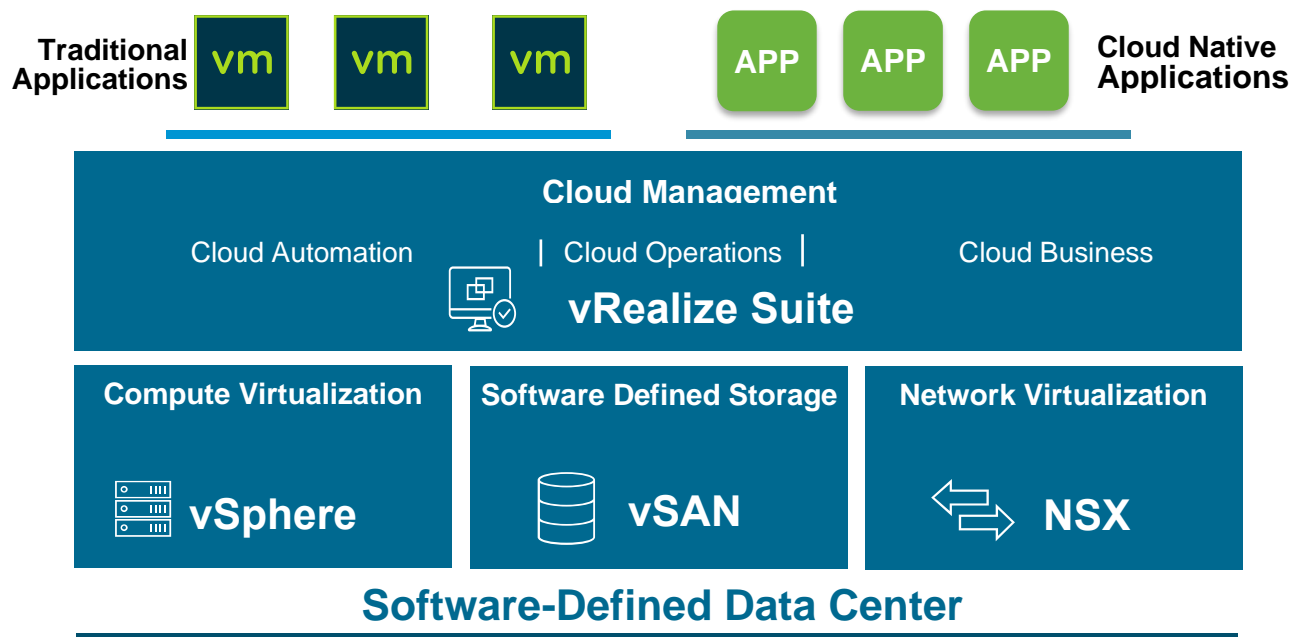
### C.1 VMware SDDC vision

The VMware vision of the modern data center starts with a foundation of software-defined infrastructure and is based on the value customers realize from a standardized architecture. It is a fully integrated hardware and software stack, simple to manage, monitor and operate. The VMware approach to the SDDC delivers a unified platform that supports any application and provides flexible control. The VMware architecture for the SDDC empowers companies to run private and hybrid clouds and to leverage unique capabilities to deliver key outcomes that enable efficiency, agility and security.

The fully virtualized data center is automated and managed by intelligent, policy-based data center management software, vastly simplifying governance and operations. A unified management platform enables centralized monitoring and administration of all applications across physical geographies, heterogeneous infrastructure and hybrid clouds. Workloads can be deployed and managed in physical, virtual and cloud environments with a unified management experience. IT becomes agile, elastic and responsive to a degree never before possible.

The VMware SDDC is based on well-established products from VMware. vSphere, vSAN and NSX provide compute, storage and networking virtualization to the SDDC and the vRealize Suite brings additional management, self-service, automation, intelligent operations and financial transparency. This forms a solid foundation to host both traditional and cloud-native application workloads.

**Figure 29** VMware software-defined data center architecture



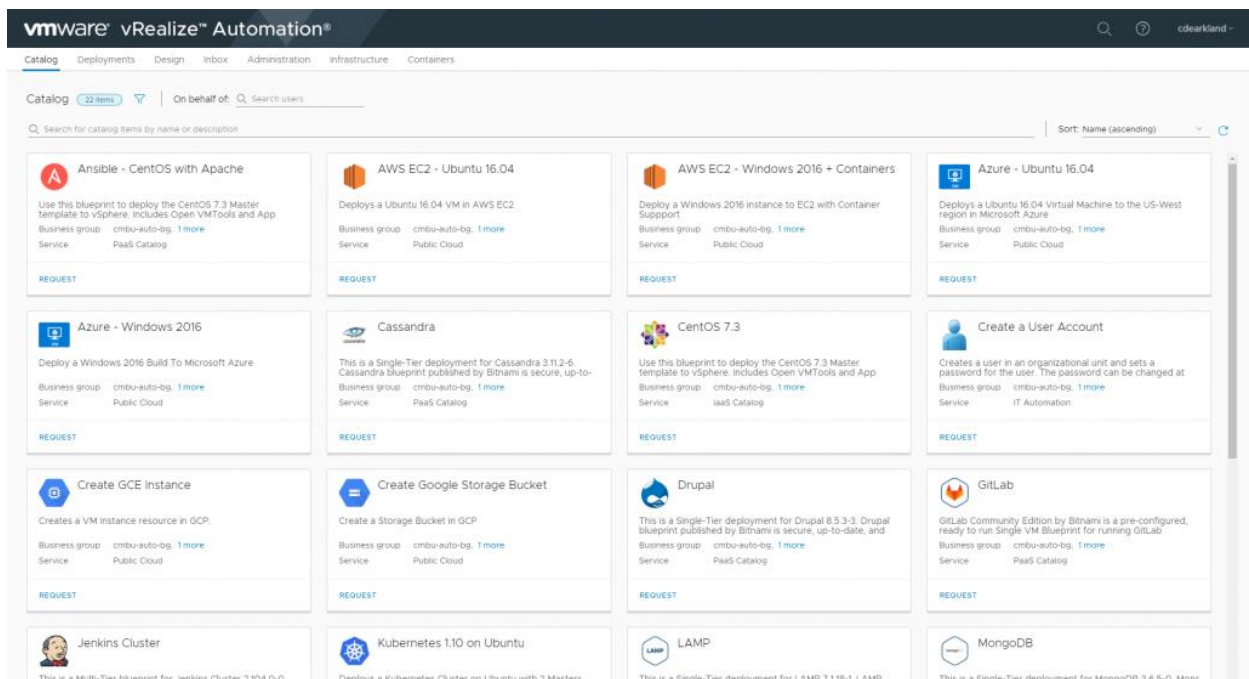
## C.1.1 IT service delivery automation

Organizations that are running traditional hardware data center architectures are forced to rely on manual processes, scripting, and complicated communication between teams to get new applications to market. They experience lengthy and costly challenges provisioning networks, and troubleshooting manual process configuration errors. By transforming to an SDDC, organizations can automate and manage IT processes in software. A fully automated environment can dramatically reduce the production-ready infrastructure and application component provisioning time from days or weeks down to a matter of minutes.

As part of the VMware SDDC cloud management platform, VMware vRealize Automation (vRA), can solve the challenges observed in traditional data center architectures with comprehensive and extensible automation capabilities, providing a self-service cloud experience. The ability to integrate into existing processes maximizes the SDDC platform return on investment (ROI) and ensures that it is not just an island in the environment.

Service architects use a convenient visual interface to design service blueprints that can span one or multiple VM templates, logical networks, load balancers, security policies, software components and scripts. Using this approach, they can model comprehensive IaaS and application services, which then can be exposed to end-users via the customizable self-service catalog as shown by the example in Figure 30. Provisioning and lifecycle management of these standardized services (e.g. scaling out of the application components, change requests, de-provisioning) can be fully automated, accelerating IT service delivery and eliminating error-prone operations, that translates into reduced operational costs and improved end-user experience.

**Figure 30** Sample self-service catalog configured within vRealize Automation



With built-in orchestration and a rich choice of pre-defined plugins, automated workflows can be built to integrate the platform with the external environment, including backup, configuration management, CMDB, service desk systems, and other ITSM tools. By leveraging orchestrator workflows, it is possible to define and

expose XaaS (anything-as-a-service) in the self-service catalog. All of these services can be consumed by end-users via a web-based portal, or by developers through the API or CLI.

vRealize Automation policies provide governance for the IT services being offered via the platform. The service catalog can be customized, making sure that the services are only exposed to appropriate users and groups. Reservation policies can be used to prioritize the assignment of infrastructure resources and stay below quotas and to alert administrators when approaching defined thresholds. Multiple levels of approval policies can be defined for request approval from both business (cost) and technical (configuration) perspectives, eliminating potential VM-sprawl enabled by the self-service automated consumption.

It's worth noting, that the orchestration capabilities provided by vRealize Automation are focused more on workloads and integration with the external environment, enabling end users to consume these as services and at scale.

## C.1.2 Security

Security is historically one of the top concerns of organizations adopting a cloud operating model. VMware SDDC provides a holistic approach to security, which exceeds the capabilities typically found in a traditional data center architecture, very often dependent on perimeter security. In a diverse traditional infrastructure environment, it is challenging to maintain consistent operations and compliance. vRealize Automation, used in conjunction with NSX, automates an application's network connectivity, security, performance, and availability.

Network virtualization provided by NSX decouples the workloads from the underlying physical infrastructure by leveraging a network overlay technology and moves the intelligence of the network from hardware to software. A key innovation of NSX is the ability to provide network and security functions, such as switching, routing and firewalling in a distributed fashion across all hosts and within the kernel-level module of the hypervisor.

One of the great benefits provided by this approach is an enhanced distributed security model, where security policies are applied closer to the workload, using virtualization-aware, higher-level security constructs, and where security policies move with the workload. NSX helps to segment the environment, decreasing risk and the attack surface while increasing the security.

**NSX micro-segmentation** is a specific security capability that decreases the level of risk and increases the security posture of a data center. It is achieved with a distributed stateful firewalling, implemented at the kernel-level of the hypervisor and distributed across all hosts in the environment. Security policies are applied at the vNIC level, independently from the underlying physical network topology, with per-workload granularity. A grouping construct called Security Group can be leveraged to dynamically identify workloads based on matching criteria, such as VM name, Security Tag, OS type, Active Directory group, etc. Especially helpful is that when workloads are moved between hosts, the security policies automatically move with the workloads. The IT administrator can define vRealize Automation application blueprints that specify NSX security policies that contain firewall rules, intrusion detection integration, and agentless anti-virus scanning at each application tier to allow application and per-tier security. Deploying network security at the application level or between application tiers to ensure that firewall rules are placed as close to the virtual machine as possible provides a true defense-in-depth solution that was too expensive and difficult to implement for a transitional hardware-based infrastructure.

vRealize Automation provisions, updates and decommissions network and security services in lockstep with virtualized applications. Network and security services are deployed as part of the automated delivery of the application, consistent with its connectivity, security, and performance requirements.



NSX-T brings the advanced security features, including micro-segmentation to the cloud native applications. It supplies Kubernetes clusters with advanced container networking and security features, such as micro-segmentation, load balancing, ingress control, and security policies. NSX furnishes the complete set of Layer 2 through Layer 7 networking services that is needed for pod-level networking in Kubernetes. You can quickly deploy networks with micro-segmentation and on-demand network virtualization for containers and pods.

VMware SDDC security is obviously not limited to NSX and micro-segmentation. Encryption protects the confidentiality of information by encoding it to make it unintelligible to unauthorized recipients. In VMware SDDC, data on the datastore can be encrypted using native vSAN encryption, individual VMs can be encrypted using vSphere Encryption, and VMs in motion can be encrypted using vMotion encryption. Additional levels of encryption may be configured based on the application requirements.

vSAN encryption is the easiest and most flexible way to encrypt data at rest because the entire vSAN datastore is encrypted with a single setting. This encryption is cluster-wide for all VMs using the datastore. Normally, encrypted data does not benefit from space-reduction techniques such as deduplication or compression. But with vSAN, encryption is performed after deduplication and compression, so it takes full advantage of these space reduction techniques.

VMware AppDefense is a data center endpoint security product that protects applications running in VMware SDDC. Unlike existing endpoint security solutions that chase threats, AppDefense focuses on monitoring applications against their intended state and responds automatically when they deviate from that intended state, indicating a threat. When a threat is detected, AppDefense can trigger vSphere and VMware NSX to orchestrate the correct response to the threat, without the need for manual intervention.

### C.1.3 Hybrid cloud ready

VMware SDDC can be deployed as a private cloud on premises or off-site using secure infrastructure-as-a-service (IaaS) operated by VMware or VMware certified partners.

Customers can build a true hybrid cloud, by integrating their private cloud with VMware Cloud™ on AWS. With Hybrid Linked Mode a VMware Cloud on AWS vCenter Server instance can be linked with an on-premises VMware vCenter® Single Sign-On domain. Once linked the inventories of both vCenters can be viewed and managed from a single vSphere Client interface, and workloads can be easily migrated between them.

Multiple public cloud providers can be connected to vRealize Automation as endpoints. In this case, the automated service provisioning and basic lifecycle management operations can be extended to popular public cloud IaaS services using the same self-service portal, while maintaining the same governance principles as in the private cloud. This provides greater transparency, increases internal control and eliminates “shadow IT.” The organization IT department can become a service broker for their internal customers, enabling a multi-cloud experience. The VMware vRealize Business for Cloud component, integrated into the same self-service portal, can be used to provide cost transparency and showback.

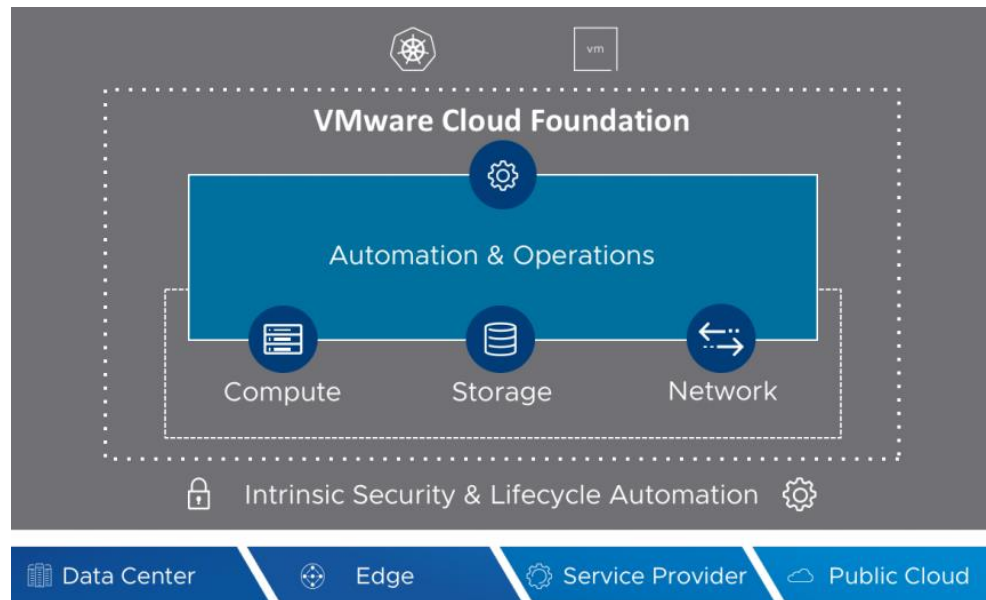
Additionally, the inclusion of an optional VMware HCX® component can provide workload mobility between enterprise sites and VMware Cloud on AWS. It enables large scale application mobility between sites with secure live migration enabling customers to transform their applications and datacenters more rapidly and securely.

To learn more about VMware HCX, please visit the [product website](#).

## D VMware Cloud Foundation

VMware Cloud Foundation is an integrated software stack that bundles compute virtualization (VMware vSphere), storage virtualization (VMware vSAN), network virtualization (VMware NSX), cloud management and operations (VMware vRealize Suite) and Kubernetes-based container services (VMware Tanzu) into a single platform that can be deployed on premises as a private cloud or run as a service within a public cloud. VMware Cloud Foundation can be a common platform for running traditional and next generation containerized applications. It helps to break down the traditional administrative silos in data centers, merging compute, storage, network provisioning, and cloud management to facilitate end-to-end support for application deployment.

**Figure 31** VMware Cloud Foundation software stack



VMware Cloud Foundation is an integrated software platform. Its SDDC Manager component automates the lifecycle management of a complete software-defined data center on standardized hyper-converged architecture. It can be deployed on premises on a broad range of supported hardware or consumed as a service in the public cloud. With integrated cloud management capabilities, the end result is a hybrid cloud platform that spans private and public environments, offering a consistent operational model based on well-known vSphere tools and processes, and freedom to run applications anywhere without the complexity of re-writing applications.

### D.1 Key features and capabilities

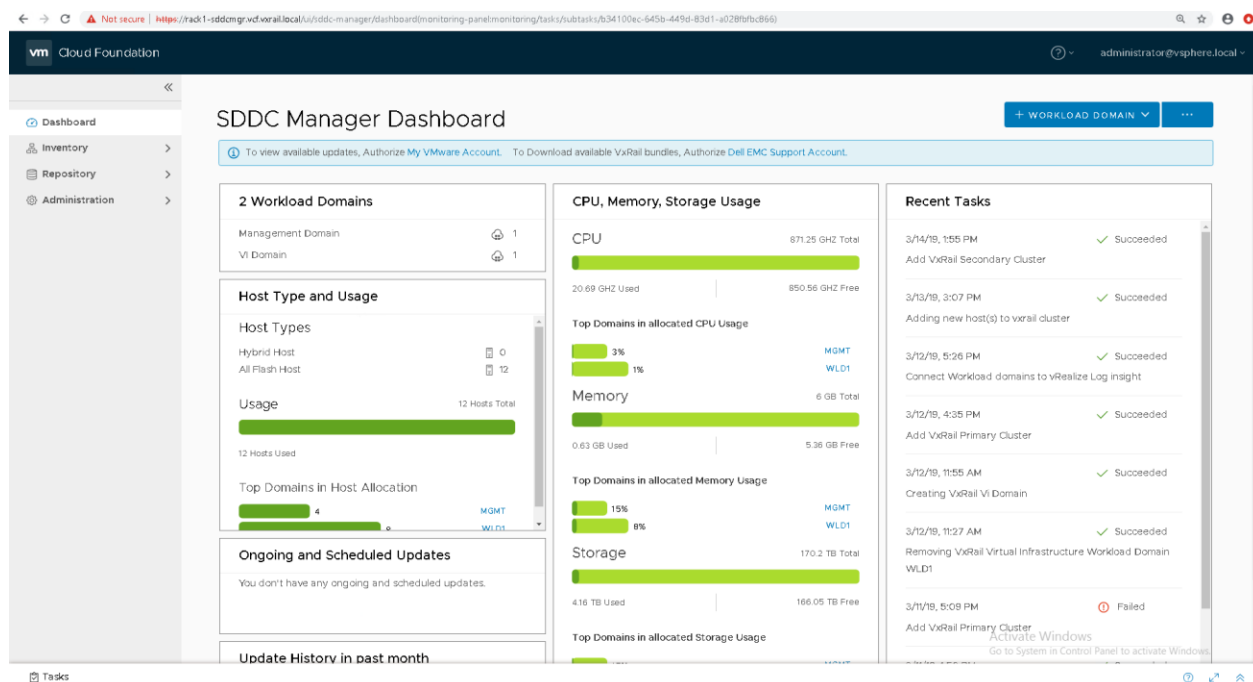
- **Integrated stack:** An engineered solution that integrates the entire VMware software-defined stack with guaranteed interoperability, freeing organizations from dealing with complex interoperability matrixes.
- **Enterprise-grade services,** based on VMware technologies: vSphere, vSAN, NSX, and vRealize Suite delivering enterprise-ready cloud infrastructure services for both traditional and containerized applications.

- **Built-in intrinsic security** delivers network-level micro-segmentation, distributed firewalls and Virtual Private Network (VPN), compute-level encryption for VM, hypervisor and vMotion, and storage-level encryption for data at rest and clusters.
- **Self-driving operations** enable self-driving health, performance, capacity, and configuration management to scale and manage the environment efficiently.
- **Self-service automation** automates the delivery of IaaS and application services via blueprints (templates) that bind compute, storage, networking, and security resources through policies.
- **Standardized architecture** automatically deploys a hyper-converged architecture based on a VMware Validated Designs for SDDC, ensuring quick, repeatable deployments while eliminating risk of misconfiguration.
- **Storage elasticity and high performance** implements a hyper-converged architecture with all-flash performance and enterprise-class storage services including deduplication, compression, and erasure coding.
- **Automated lifecycle management** includes unique lifecycle management services that automates day 0 to day 2 operations, from deployment to configuration of the cloud environment, to on-demand provisioning of infrastructure clusters (workload domains) to patching/upgrades of the complete software stack.
- **Automated deployment** automates the bring-up process of the entire software platform, including creation of the management cluster, configuration of storage, deployment of platform components/management VMs, and provisioning using standardized architecture designs.
- **Workload domain and cluster provisioning** enables on-demand provisioning of isolated infrastructure clusters to separate workloads.
- **Simplified patching and upgrades** enable a simplified patching/upgrading process of the software platform (including VMware vCenter Server®). Cloud admins have the flexibility to choose the timing and scope of the updates.
- **Simple path to hybrid cloud** dramatically simplifies the path to hybrid cloud by delivering a common platform for private and public clouds, enabling a consistent operational experience and the ability to quickly and easily move workloads at scale across clouds without re-architecting applications, leveraging VMware HCX.
- **Tanzu Runtime Services and Hybrid Infrastructure Services** that provide the basis for the cloud infrastructure and container ecosystems to accelerate developer productivity.

## D.2 SDDC Manager

SDDC Manager automates configuration, provisioning, and lifecycle management of the entire SDDC stack, making it simple for the administrators to build and maintain the SDDC. It also automates the installation and configuration of vRealize Suite components. SDDC Manager complements well-known VMware management tools such as vCenter Server and vRealize Operations that continue to be available for advanced administration tasks and integration with third-party software tools.

Figure 32 SDDC Manager main dashboard



The automated deployment of VMware Cloud Foundation is performed with the help of Cloud Builder, which manages the orchestration of the initial deployment and configuration of an SDDC platform ensuring that it adheres to the architecture best practices outlined within VMware Validated Designs. Cloud Builder creates the management domain with the VMware SDDC components. Cloud Builder has been uniquely engineered to integrate with VxRail. It is aware of the VxRail architecture and VxRail Manager. When Cloud Builder is deployed with the VxRail profile enabled, it only deploys the additional platform components that have not already been deployed by VxRail Manager such as SDDC Manager, NSX, etc.

### D.3 Simplified resource management with workload domains

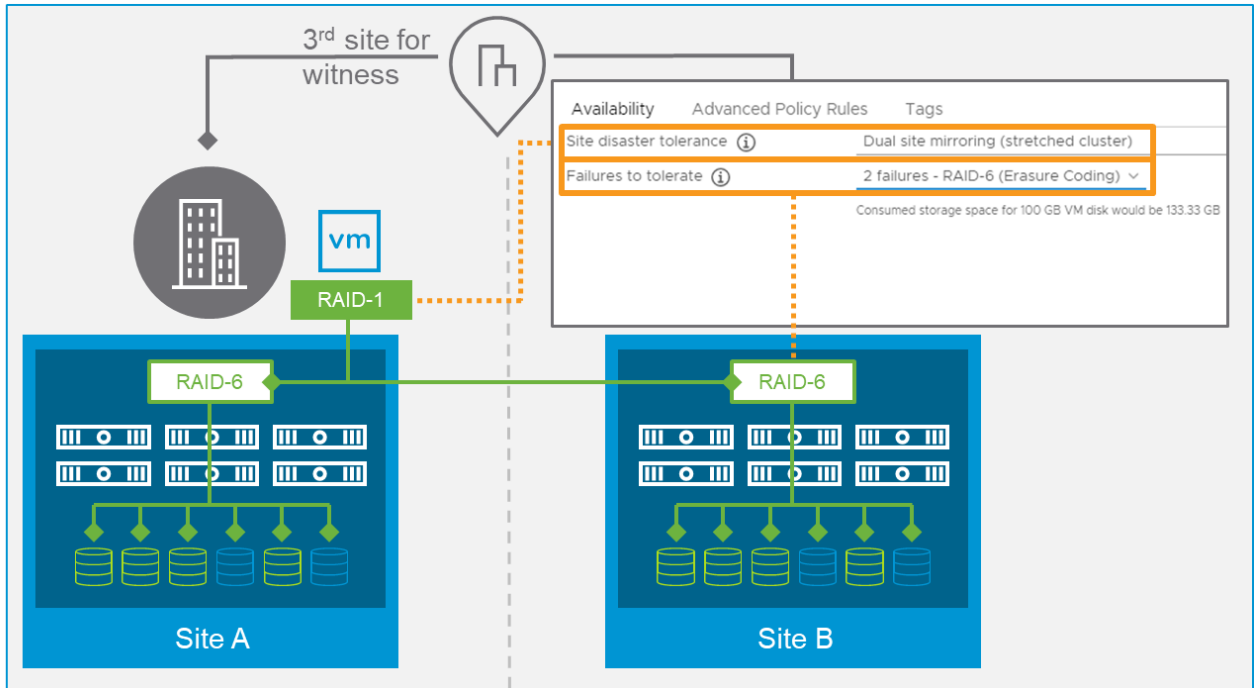
VMware Cloud Foundation can scale up from a set of four or eight initial nodes, in increments as small as one server, up to thousands of servers in a single Cloud Foundation environment. The physical compute, storage and network infrastructure becomes part of a single shared pool of virtual resources that is managed as one system using SDDC Manager, removing any physical constraints of a single physical server or rack. From this shared pool, customers can carve out separate pools of capacity called workload domains, each with its own set of specified CPU, memory and storage requirements to support various workloads.

Workload domains are a policy-driven approach for defining performance, availability, and security parameters. SDDC Manager automatically implements a deployment workflow to translate the workload domain specifications into the underlying pool of resources. Through the automation of tasks and workflows, SDDC Manager simplifies provisioning, monitoring, and ongoing management of both logical and physical resources of VMware Cloud Foundation.

## D.4 Support for multiple instances and availability zones

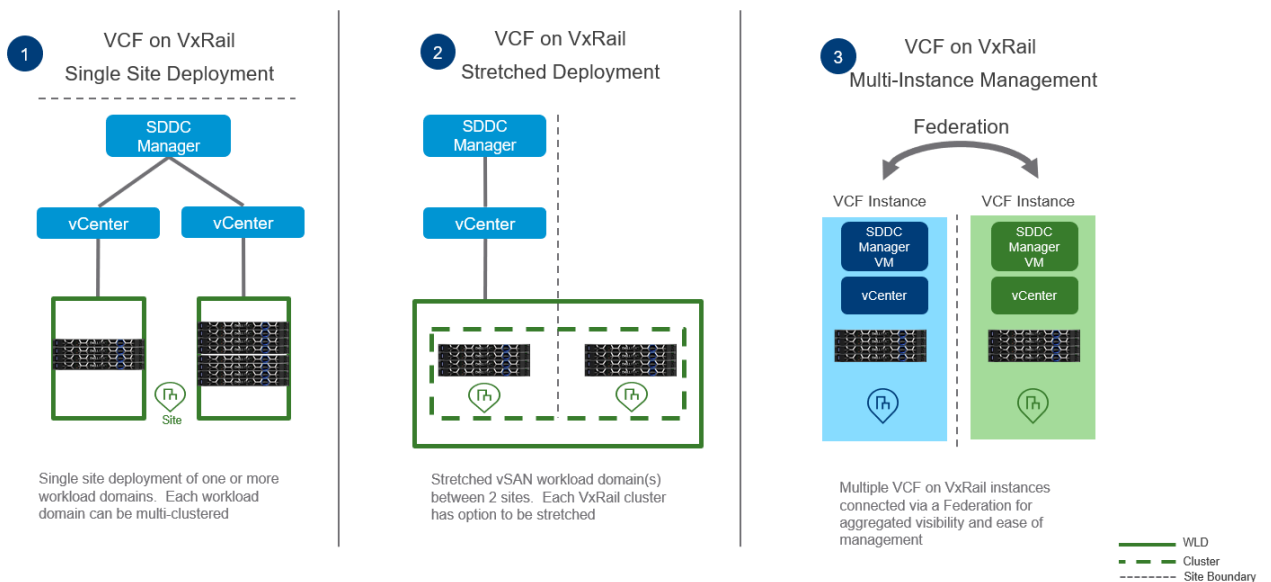
By leveraging additional guidance contained in the VMware Validated Designs, customers can deploy VMware Cloud Foundation environments in multiple availability zones topologies to support a variety of multi-site, and stretched cluster use cases.

**Figure 33** VMware Cloud Foundation stretched cluster support



VMware Cloud Foundation 3.9 and later supports multi-instance management, which allows multiple VCF instances to connect via a federation for aggregated visibility and ease of management. Figure 34 illustrates single site, stretched and multi-instance architectures:

**Figure 34** Various architectures supported by VMware Cloud Foundation

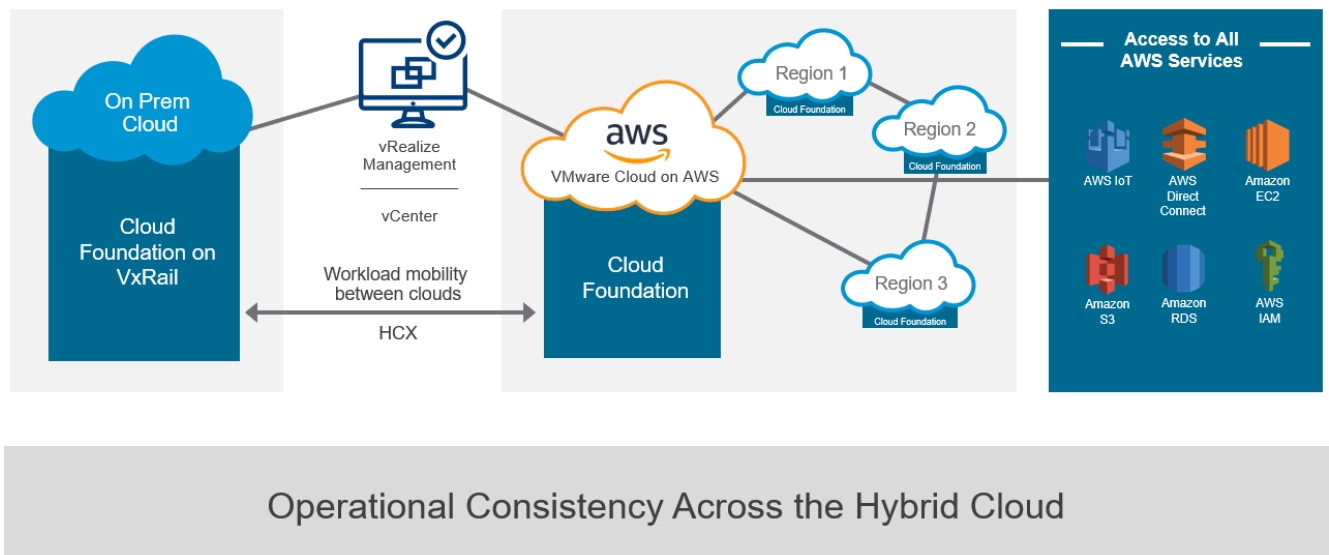


## D.5 Expanding to public cloud to deliver a true hybrid cloud experience

VMware Cloud Foundation dramatically simplifies the path to hybrid cloud by delivering a common platform for private and public clouds, enabling a consistent operational experience and the ability to quickly and easily move workloads at scale across clouds without re-architecting applications, leveraging VMware HCX.

VMware Cloud on AWS is an on-demand service to run applications across vSphere-based cloud environments with access to a broad range of AWS services. Powered by VMware Cloud Foundation, this service integrates vSphere, vSAN, and NSX along with VMware vCenter management, and is optimized to run on dedicated, elastic, bare-metal AWS infrastructure. With this service, cloud-based resources can be managed with familiar VMware tools. You get workload portability across your on-premises infrastructure and AWS cloud. Figure 35 shows building a true hybrid cloud environment, connecting on-premises and off premises data centers that is compatible and distributed.

**Figure 35** Building a hybrid cloud with VMware Cloud on AWS



## E VMware SDDC common component details

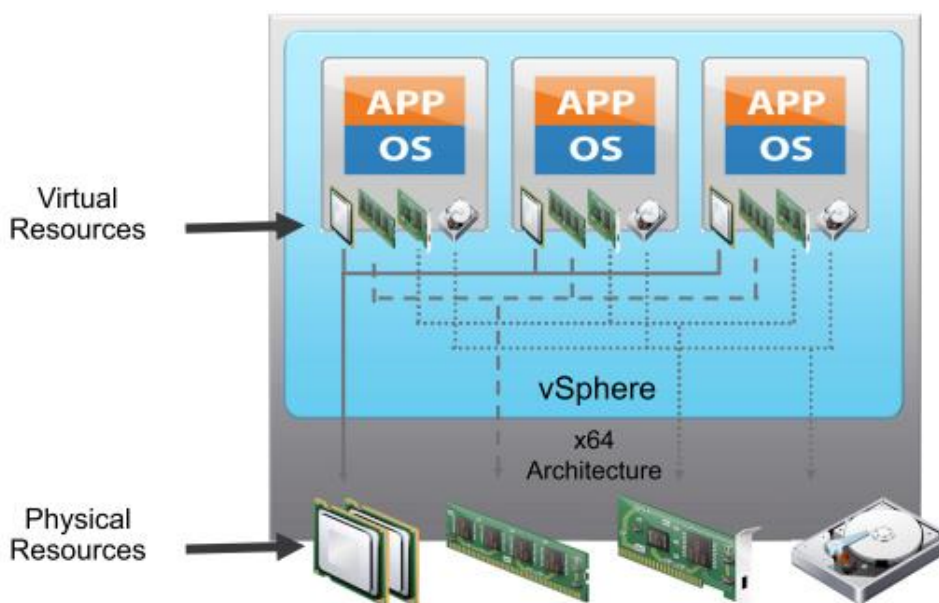
### E.1 VMware vSphere

The VMware vSphere software suite delivers an industry-leading virtualization platform to provide application virtualization within a highly available, resilient, efficient on-demand infrastructure. ESXi and vCenter are components of the vSphere software suite. ESXi is a hypervisor installed directly onto a physical server node, enabling it to be partitioned into multiple virtual machines (VMs). VMware vCenter server is a centralized management application that is used to manage the ESXi hosts and VMs.

vCenter Server is the centralized console for managing a VMware environment. It is the primary point of management for both server virtualization and vSAN. vCenter Server is the enabling technology for advanced capabilities such as VMware vSphere® vMotion®, VMware vSphere® Distributed Resource Scheduler™ (DRS) and VMware vSphere® High Availability (HA). vCenter supports a logical hierarchy of datacenters, clusters and hosts, which allows resources to be segregated by use cases or lines of business and allows resources to move dynamically as needed. This is all done from a single interface.

VMware ESXi is an enterprise-class hypervisor that deploys and services VMs. Figure 36 illustrates the basic ESXi architecture.

**Figure 36** vSphere ESXi architecture



ESXi partitions a physical server into multiple secure, portable VMs that can run side-by-side on the same physical server. Each VM represents a complete system with processors, memory, networking, storage and BIOS. Guest operating systems and software applications can be installed and run in the VM without any modification.

The hypervisor provides physical-hardware resources dynamically to VMs as needed to support the operation of the VMs. The hypervisor enables VMs to operate with a degree of independence from the underlying physical hardware. For example, a VM can be moved from one physical host to another. Also, the VM's virtual disks can be moved from one type of storage to another without affecting the functioning of the VM.



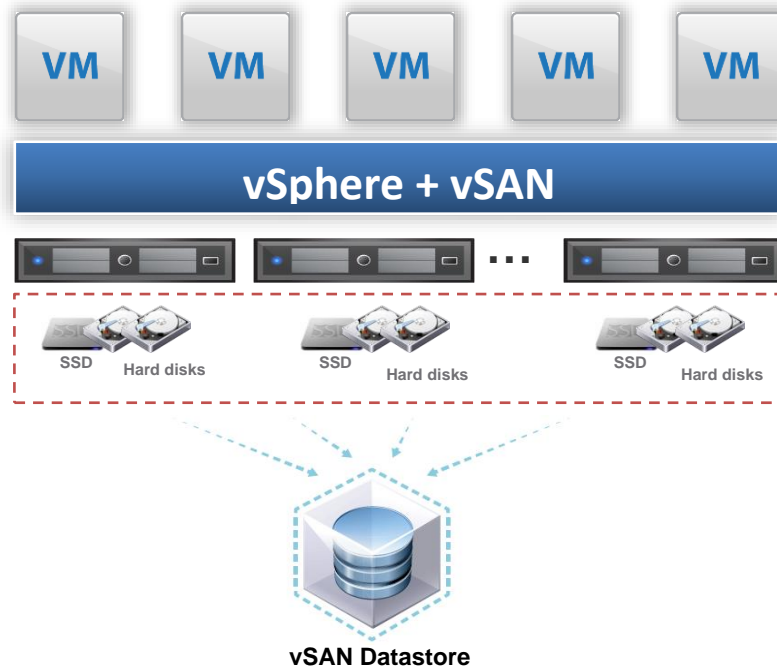
ESXi also isolates VMs from one another. When a guest operating system on a host fails, other VMs on the same physical host are unaffected and continue to run. VMs share access to CPUs and the hypervisor is responsible for CPU scheduling. In addition, ESXi assigns VMs a region of usable memory and provides shared access to the physical network cards and disk controllers associated with the physical host. Different VMs can run different operating systems and applications on the same physical computer.

## E.2 VMware vSAN

vSAN is VMware's software-defined storage solution built from the ground up for vSphere VMs. It abstracts and aggregates locally attached disks in a vSphere cluster to create a storage solution that can be provisioned and managed from vCenter and the vSphere Web Client. vSAN integrates with the entire VMware stack, including features like vMotion, HA and DRS. VM storage provisioning and day-to-day management of SLAs can be all be controlled through VM-level policies that can be set and modified on-the-fly. vSAN delivers enterprise-class features, scale and performance, making it the ideal storage platform for VMs.

The figure below shows an example of a hybrid configuration where each node contributes storage capacity to the shared storage vSAN datastore. The SSD drive provides caching to optimize performance and hard disk drives (HDD) for capacity. All-flash configurations (not shown) use flash SSDs for both the caching tier and capacity tier.

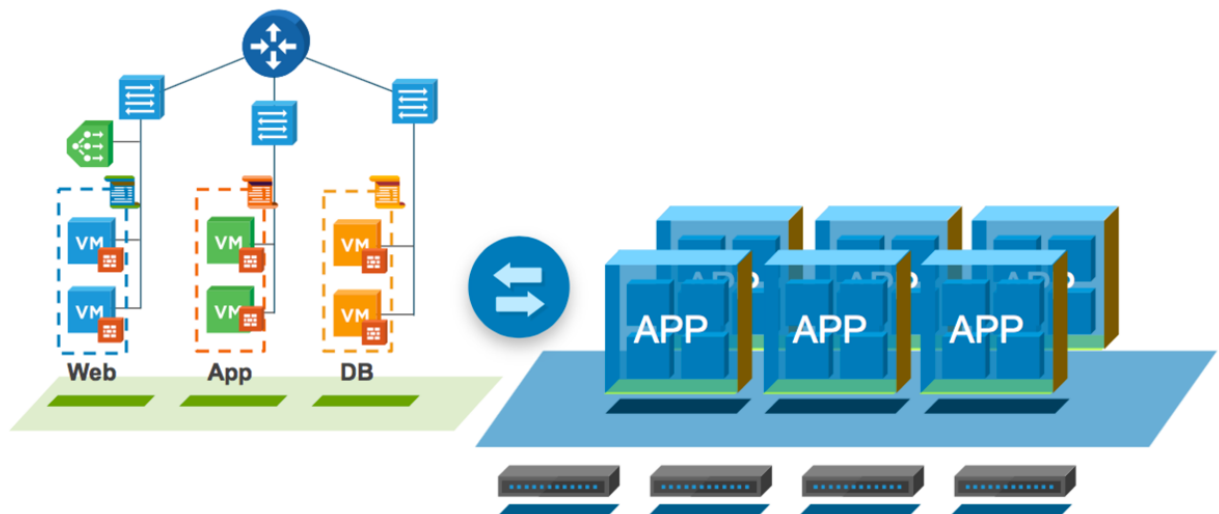
Figure 37 vSAN datastore



## E.3 VMware NSX

NSX network virtualization delivers the operational model of a VM to the network infrastructure. NSX software-defined networking injects improved security into the entire data center infrastructure. With NSX, network functions including switching, routing and firewalling are embedded in the hypervisor and distributed across the environment. This effectively creates a “network hypervisor” that acts as a platform for virtual networks and services as shown in Figure 38 below.

**Figure 38** NSX software-defined networking



NSX virtual networks leverage automated, policy-based provisioning and multi-tenant isolation to simplify network management, even for complex multi-tier network topologies. NSX reproduces the entire network model in software, enabling any network topology to be created and provisioned in seconds. Users can create multiple virtual networks with diverse requirements, leveraging a combination of the services offered via NSX, to build more agile and secure environments.

VMware offers two flavors of NSX: NSX-V and NSX-T. NSX-V, is the version that is tied to VMware vSphere ecosystem and is dependent on vCenter and was VMware’s first SDN offering. On the other hand, NSX-T is VMware’s next generation software-defined networking solution, which is “unlocked” from vSphere and vCenter. It additionally supports cloud-native applications, bare metal workloads, multiple hypervisors, public clouds and multi-cloud environments. Both NSX-V and NSX-T reproduce the complete set of networking services (e.g. switching, routing, firewalling, QoS) all in a network virtualization layer which is an abstraction between the physical and virtual networks.

To learn more about NSX architecture in the context of VMware Cloud Foundation on VxRail, please consult *VMware Cloud Foundation on VxRail Architecture Guide*.

## E.4 vRealize Suite and vRealize Network Insight

Most software-defined data centers are hybrid, with workloads a mix of traditional and modern application architectures. They are provisioned in an increasingly virtualized mix of physical and virtual environments, managed both on-premises in private clouds and off-premises in public clouds. The concept of a cloud management platform has evolved as a response to this complex set of management requirements. VMware's vRealize cloud management platform delivers the management capabilities to effectively manage the complete lifecycle of services delivered in a hybrid IT environment.

VMware's vRealize cloud management platform includes:

- **vRealize Automation** automates the delivery of IaaS or application services via blueprints (templates) that bind compute, storage, networking and security resources through policies.
- **vRealize Business for Cloud** automates costing, usage metering and service pricing of virtualized infrastructure and cloud services.
- **vRealize Operations** provides intelligent health, performance, capacity and configuration management. vRealize Operations offers performance and health monitoring and capacity planning as well as custom dashboards, capacity modeling and customized alerting. These insights help administrators maintain compliance and efficiently detect and resolve any issues that may arise.
- **vRealize Log Insight** provides real-time log management and log analysis. vRealize Log Insight lets administrators monitor physical and virtual infrastructure to avoid failures and performance issues. vRealize Log Insight provides centralized log aggregation and analysis with search and filter capabilities. This provides the ability to monitor all workloads from a single place.
- **vRealize Suite Lifecycle Manager** provides automated installation, configuration, upgrade, patch, drift remediation, health and content management of vRealize products.
- **vRealize Network Insight** provides intelligent operations for software-defined networking and security. It accelerates micro-segmentation planning and deployment, enables visibility across virtual and physical networks, and provides operational views to manage and scale VMware NSX deployments.

## E.5 VMware Tanzu

VMware Tanzu is a portfolio of products and services for building, running and managing modern applications on any cloud. It simplifies multi-cloud operations while freeing developers to move faster with easy access to the right resources. VMware Tanzu enables development and operations teams to work together in new ways that deliver transformative business outcomes.

The prominent use cases are:

- **Modernize existing applications** - customers may decide to containerize existing workloads to run in the cloud for quick gains in security and manageability or rearchitect and rewrite existing, business-critical applications to be continuously delivered and resilient. Simultaneously, they can modernize their IT infrastructure to simplify the operations, with security, stability, and scale in mind.
- **Improve developer experience** - with Tanzu, developers are set up with a complete software supply chain that can get them to production fast and continuously. They can deliver software quickly with a secure, automated platform. They can access a self-service catalog of open-source building blocks such as application components, databases, and runtimes. They can also maintain the visibility of applications in production to troubleshoot faster and improve them.
- **Speed Kubernetes enterprise adoption** - VMware Tanzu addresses the Day 1 and Day 2 Kubernetes operations burden with a complete, easy-to-upgrade Kubernetes runtime with pre-integrated and validated components. It enables customers to run the same K8s across data center, public cloud, and edge for a consistent, secure experience for all development teams. It also can be used with existing data center tools and workflows to give developers secure, self-serve access to conformant Kubernetes in customers' VMware private clouds.
- **Simplify cloud migration** - migration to the cloud is not only about the infrastructure, but more about having applications that can run in the cloud. VMware Tanzu and Pivotal Labs help customers modernize existing applications and show the best way to build new, cloud-native apps. Customers can migrate their apps to the cloud when they are ready and get the portability they need to move to different clouds as operations require.
- **Centrally manage clouds, clusters, and apps** - VMware Tanzu provides centralized lifecycle and policy management for customer's all Kubernetes clusters across multiple teams and clouds. For customers deploying microservices, Tanzu can scale with complete service mesh management. Customers also get an observability platform that enables every team to understand how applications are operating - and resolve issues in real-time before they impact the business.

VMware Tanzu portfolio is illustrated in Figure 39. It is divided into the following categories:

### **BUILD:**

- **Tanzu Application Service** - an intrinsically secure, scalable platform that automates the release and operation of software, optimized for Spring, .NET, Go, Node.js, and more.
- **Tanzu Application Catalog** - a customizable selection of open source, production-ready containers from the Bitnami collection.
- **Tanzu Build Service** - automation for creating, managing, and governing containers at an enterprise scale.

- **Tanzu Data Services** - a bundle of data and messaging services (GemFire, RabbitMQ, and SQL) providing an on-demand data layer for real-time, modern apps.
- **Spring** - the world's most popular Java framework that accelerates cloud-native development.

**RUN:**

- **Tanzu Kubernetes Grid** - an enterprise-ready Kubernetes runtime that streamlines operations across the multi-cloud infrastructure. This runtime is also integrated as a service in vSphere 7 with Kubernetes so you can run and manage your modern apps alongside your existing software.

**MANAGE:**

- **Tanzu Mission Control** - centralized management to consistently operate and secure your Kubernetes infrastructure and modern apps across multiple teams and clouds.
- **Tanzu Service Mesh** - end-to-end operational networking, visibility, and security for microservices across any runtime and any cloud.
- **Tanzu Observability** - a single platform for observing and analyzing infrastructure and application health across the multi-cloud enterprise.

**SERVICES:**

- With **VMware Pivotal Labs**, customers can master a modern way of building and operating software. Pivotal Labs helps to jumpstart application development and modernization initiatives in a results-driven, iterative way. It enables customers to create new cloud-native apps, modernize existing apps, operate their platform as a product, and transform operations with Kubernetes.

**Figure 39** VMware Tanzu portfolio

