VMWARE SD-WAN BY VELOCLOUD FOR HYPER-CONVERGED PLATFORM SOLUTION GUIDE

Version 1.0

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Executive Summary

Organizations seek to serve applications to users in their remote and branch office locations with a minimum of local infrastructure, however application performance over the wide area network is impacted by traffic congestion and network outages. In order to overcome these limitations and deliver applications reliably and with high performance organizations can implement Software-Defined Wide Area Networking (SD-WAN) in conjunction with Hyper-converged Infrastructure (HCI).

Organizations are turning to hyper-converged infrastructure (HCI) technologies to reduce the time, effort and cost to deploy applications, and to easily and securely scale up resources as users and applications are added, which enables them to deliver on their business initiatives and explore new business opportunities.

HCI is a scale-out, software-defined infrastructure that converges core data services on flash-accelerated, industry-standard servers, delivering flexible and powerful building blocks under unified management. All key data center functions run in a tightly integrated software layer—delivering services that previously required purpose-built hardware.

SD-WAN applies software-defined network virtualization technologies to WAN connections to deliver fast and secure delivery of network traffic between data centers and remote and branch offices, and to the cloud. SD-WAN optimizes delivery by dynamically using multiple available connections (MPLS, broadband, LTE) to expedite traffic via optimal paths, according to business policies, all managed from a central console. SD-WAN simplifies deployment of network services by providing operational efficiency and automation to the organization.

This solution guide describes a simple, highly configurable VMware SD-WAN By VeloCloud deployment architecture on Dell EMC VxRail hyper-converged infrastructure in an on-premises or hybrid environment. For illustration purposes, the solution scenario uses VMware SD-WAN to connect data centers to two locations – a head office and a branch office – with a minimal ROBO infrastructure. However, this solution architecture is easily enhanced to scale to many locations via SD-WAN enabled WAN architectures.

This solution guide is intended for enterprise architects, solution architects, sales engineers, field consultants, technical account managers, and IT administrators who are responsible for designing, implementing, and operating data-center solutions. It describes an integrated technology stack for data center services that data center administrators can quickly deploy in an on-prem or hybrid environment, and then easily adapt to address ever-changing consumer engagement requirements using software-defined workflows.

Challenges with Branch Office Wide Area Networks

WAN technologies used in most branch offices today have changed little, if at all, since the 1990s. Traditional wide area networks employ rigid architectures that are optimized around private data center applications. These architectures are unable to seamlessly integrate with cloud computing, SaaS, network virtualization, and other industry advances. Branch offices with only private circuit connections rely on backhauling all cloud applications, SaaS, and Internet traffic through the enterprise data center, which adds latency, degrades application performance, and drives up private network bandwidth costs.

Multiprotocol Label Switching (MPLS) typically provides a high quality of service but with the tradeoff of limited capacity, higher cost, and long deployment lead times. Broadband provides fast deployments and greater capacity, but with the tradeoff of reliability.

These limitations can have the following negative impacts:

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- New applications and/or virtual desktops are inhibited by bandwidth or the lack of assured performance.
- Branch network deployments are delayed due to IT complexity.
- Workload migration is not supported by the traditional hub and spoke branch network architecture.
- Although a hybrid WAN enables enterprises to incorporate both private MPLS and broadband Internet—which can reduce costs—the approach on its own does not increase agility, performance, or simplicity.

Organizations are embracing SD-WAN technologies to solve these challenges.

HCI: The Next Infrastructure Revolution

Prior to the development of HCI technology organizations had to spec-out and source application hosting infrastructure component by component, including servers, storage, network switching and management, and then take delivery of the individual items and assemble them in the data center and the branch office locations. This process was costly and time consuming and greatly delayed deployment of applications.

Organizations are embracing hyper-converged infrastructure (HCI) technologies to solve these challenges.

HCI consists of three core components:

- Compute virtualization
- Storage virtualization
- Management

The virtualization software abstracts and pools the underlying resources and dynamically allocates them to applications running in virtual machines or containers. Users enjoy a sleek new operational model where they manage the compute, storage, and networking resources from a single tool. All key data center functions run in a tightly integrated software layer to deliver services that previously required purpose-built hardware.

VMware SD-WAN by VeloCloud for Hyper-Converged Platform

VMware SD-WAN by VeloCloud applies software-based network technologies to WAN connections. This platform:

- Seamlessly integrates with Dell EMC's hyper-converged infrastructure VxRail™ to provide a transformational approach for Wide Area Network (WAN) architectures.

- Leverages the benefits of the cloud, the bandwidth of broadband, and existing enterprise-wide network infrastructure to more efficiently and cost effectively transmit media (data, video, voice) and provide access to cloud applications from every location in the network.

- Dynamically uses multiple available connections (MPLS, broadband, LTE) to send traffic via optimal delivery paths across the entire network.

- Enables bandwidth on-demand, provides direct and optimal access to cloud-based applications, simplifies deployment of services, improves operational automation, and assures application performance.

- Enables IT organizations to deploy their data center and branch office (ROBO) infrastructure as quickly as possible, delivering an on-premise or hybrid cloud to their business.

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- Allows data center administrators to quickly deploy infrastructure resources and update software-defined workflows in response to ever-changing consumer engagement requirements.

The VMware SD-WAN by VeloCloud solution:

- Scales from small to large workloads

- Offers ease of deployment across a multi-site architecture

- Provides network agility to easily respond to evolving customer engagement models and business opportunities

- Is highly configurable for operational flexibility and tuning

- Provides centralized management and control of SD-WAN deployments at greatly reduced costs

- Enables the secure transport of data across locations via performance optimized paths

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Solution Architecture

The following figure shows the deployment architecture of the VMware SD-WAN for Hyper-Converged Platform across two sites: headquarters and a branch office.
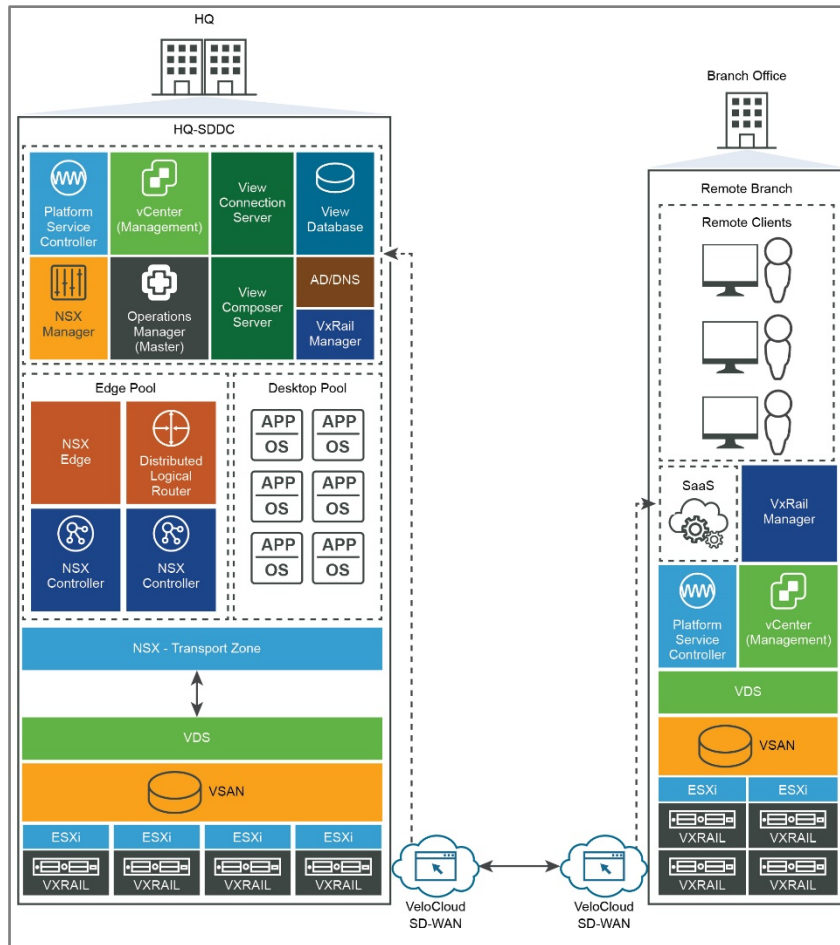
- In this deployment, the HQ and Branch Data Centers include four VxRail nodes that are interconnected using a network TOR.

- The HQ data center acts as single pod inside a physical rack. The pod encompasses the combinations of servers, storage, and network that are required to fulfill a specific role within the virtual infrastructure.

- The different functions of the SDDC (management, Edge, and desktop pool) are implemented as a standardized set of building blocks on a VxRail vSphere cluster and separated with resource pools. Each resource pool contains the appropriate compute and memory resources to balance each workload within the VxRail vSphere cluster.

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- The Branch Data Center consists only of remote clients and the local tools necessary for the branch to perform remote user tasks. Remote users connect and consume resources/applications and desktops from the HQ data center over secure SD-WAN connections.

This solution provides a prescriptive architecture that is highly reconfigurable and easy to repurpose. For organizations focused on providing self-service oriented IT services and automation, this solution simplifies data center deployment, minimizes the risk of automation changes, and provides an easy upgrade path from a small-scale to a large-scale virtual infrastructure.

Physical Infrastructure

The following figure shows the physical infrastructure of the VMware SD-WAN for Hyper-Converged Platform.
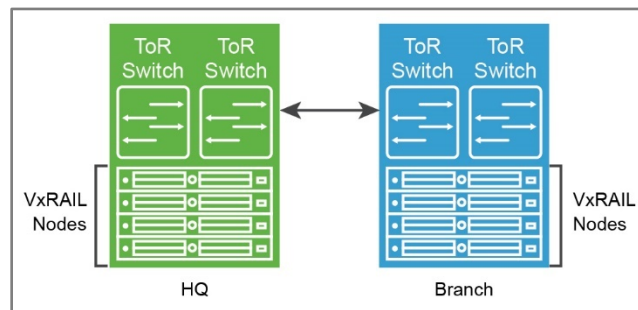
This solution relies on the following underlying physical components:

- A pair of Top of Rack (ToR) network switches on each side
- Four node VxRail appliances in two sites (HQ and branch)

The pair of ToR network switches in each location provide 10 GbE connectivity to the four servers, as well as connectivity to the branch network.

Within this design, a single VxRail cluster is deployed for Management, Edge, and the VDI desktop pool. Upon scaling, additional VxRail nodes can be added to the cluster. The figure above shows how these components are integrated and connected.

In an enterprise data center architecture, however, a layer-3 leaf-and-spine network design is recommended for simplicity, scalability, and high bandwidth (see *VMware Validated Design for Software-Defined Data Center*). With this architecture, the physical network architecture is tightly coupled with the pod architecture. For the network design, VMware recommends using the prescriptive VMware Validated Design (VDD) as well as the principles described in the *Dell EMC VxRail Network Guide* and the *VMware Validated Design 4.2 on VxRail Deployment Guides*.

Virtual Infrastructure

The VMware SD-WAN for Hyper-Converged Platform is a highly automated, hyper-converged infrastructure appliance. The appliance helps reduce capital and operational costs while providing a fully integrated, preconfigured, and pre-tested VMware hyper-converged solution. VxRail is a hyper-converged appliance offering SDDC in a box.
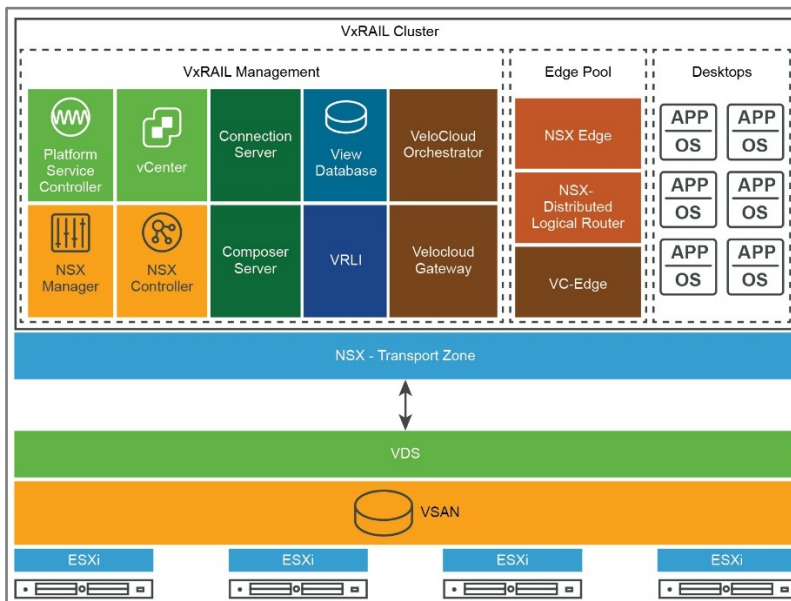
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The virtual infrastructure design includes the VMware software components that make up the virtual infrastructure layer and that support the complete SDDC platform, auto installed, and pre-configured by VxRail. In addition to the flexibility in hardware choice, VxRail comes with the following software:

- VMware vCenter
- VMware ESXi
- VMware vSAN (Software-Defined Storage)
- VMware vRealize Log insight
- Dell EMC VxRail Manager
- Dell EMC RecoverPoint for VMs

Optionally, VMware's for vSphere (NSX-V) can be installed to enhance the solution with all the NSX-V benefits of network virtualization, security, and automation. As part of this solution design, VMware NSX-V has been deployed manually on the VxRail system to support the use case.

The following figure shows how each of the components are logically situated in the VxRail virtual infrastructure. In addition, the VMware SD-WAN was deployed on top of this as a virtual appliance and placed in the VxRail MSDDanagement resource pool.

Virtual Network Design

A well-designed network helps the organization meet its business goals, prevents unauthorized access, and provides timely access to business data. This network virtualization design uses vSphere and VMware for vSphere to implement virtual networking.

Network Segmentation and VLANs

Separating different types of traffic is required to reduce contention and latency. Separate networks are also required for access security. High latency on any network can negatively affect performance. Depending on

the application or service, high latency on specific virtual machine networks can also negatively affect performance. Use information gathered from the current state analysis and from interviews with key stakeholders and SMEs to determine which workloads and networks are especially sensitive to high latency.

Virtual Networks

Determine the number of networks or VLANs that are required depending on the type of traffic that includes the vSphere operational traffic, and traffic that supports the organization's services and applications. Upon startup, VxRail automates and pre-configures the virtual network, including:

- Management
- vMotion
- Virtual SAN (VSAN)

For this solution design, the following additional VLANs are configured.

- WAN – for VMware SD-WAN VCO, VCG interface communication
- LAN – for VMware SD-WAN inside network
- VXLAN – for NSX VTEP network
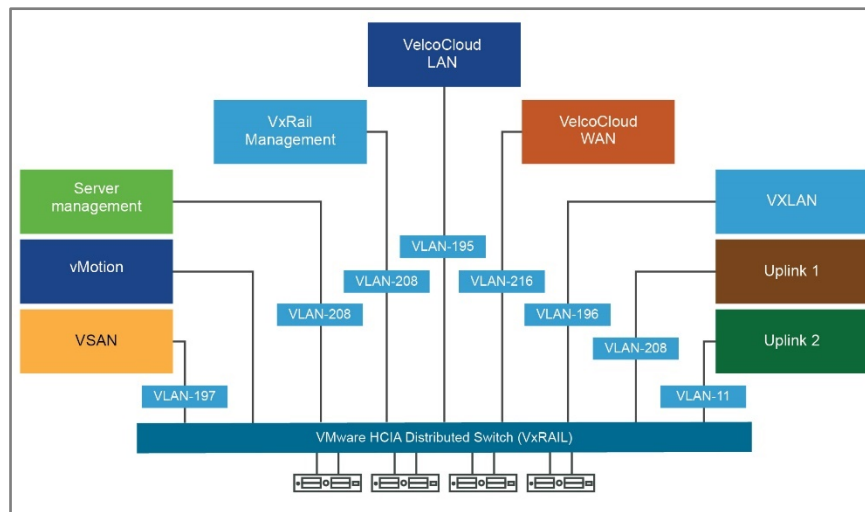
The following table describes the port group / VLAN mapping.

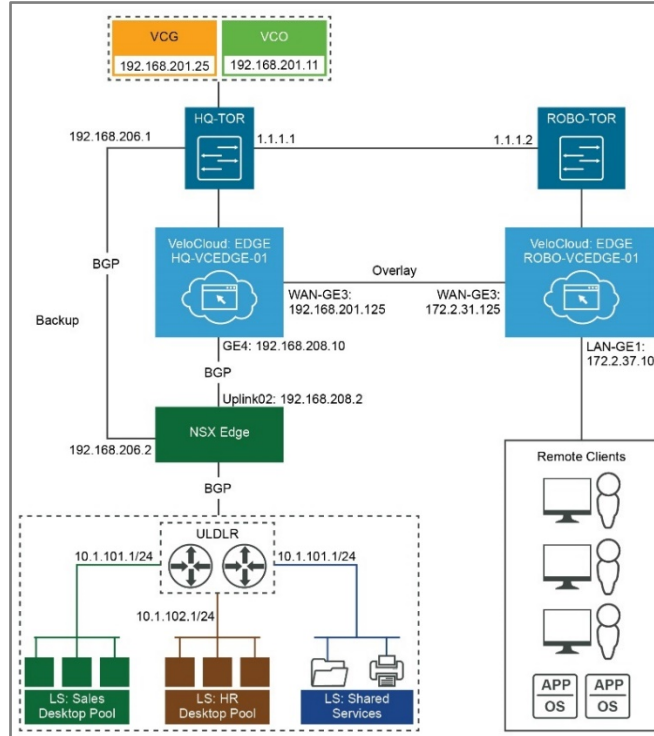| Port Groups	VLAN	Auto (A)/ Manual (M)
VxRail Management	208	A
vCenter Server Network	208	A
vSphere vMotion	193	A
Virtual SAN	197	A
VXLAN	196	M
VeloCloud WAN	11	M
VeloCloud LAN	195	M
NSX-Edge-Uplink1	208	M
NSX-Edge-Uplink2	216	M

Network Virtualization and SD-WAN Conceptual Design

The VMware SD-WAN for Hyper-Converged Platform brings SDN concepts to the enterprise branch WAN. Business policies implemented across the logical overlay deliver the abstraction of application flows from the underlying physical transport. Agility is achieved by making changes to traffic forwarding to meet policy as well as real-time link conditions. The VMware SD-WAN has a distributed control plane for forwarding decisions to be made locally with context, so there are no latency issues or points of failure across the WAN. Each VMware SD-WAN node receives centralized control policies for easy programmability and enterprise-wide visibility.

The following figure shows the details of an end-to-end network architecture, how an SD-WAN can be deployed along with VxRAIL and an application (such as a virtual desktop network), and how the IP space is used.

This design uses the following key components:

Component	Description
Site-HQ to Site-Branch	Direct connectivity between HQ to Branch. This can be any service provider network, such as MPLS, Broadband, etc.
vMware SD-WAN by VeloCloud Edge Network	Provides an overlay connectivity from HQ to Branch and vice versa. External (north-south) connectivity to and from the branch network acts as access points and does network peering with BGP dynamic routing protocol both upstream VMware SD-WAN Edge network and VMware SD-WAN by VeloCloud Edge Gateway.
Management Network	With the SDDC deployed on Dell EMC VxRail hyper-converged infrastructure, all management components (such as vCenter and the Platform Service Controller) work with a VLAN-backed port group. It directly communicates with an HQ-Branch routed network with a vSphere distributed switch. If NSX-V (purchased separately) is included in the design, then management components also include NSX Manager and NSX Controller.
Virtual Desktop Network	Consists of the desktop workload. This design shows three segments of virtual desktops (sales, HR, and shared services). Each of the application VMs are behind a respective logical switch with their own IP space. Each of the leaves connect back to the universal distributed logical router for internal (east-west) communication. The customer has the choice to enable firewall rules to allow/deny traffic around this logical isolated network to ensure security and isolation between virtual desktops or applications. These isolated networks are connected to universal distributed logical router (UDLR), which is further connected to the VMware SD-WAN Edge Gateway and handles the network peering with a dynamic protocol (such as BGP) to propagate all routing information.

Network virtualization with VMware NSX programmatically creates, snapshots, deletes, and restores software-based virtual networks. The result is a completely transformative approach to networking, vastly simplifying the operational model for the underlying physical network.

The main benefits for network virtualization are security, IT automation, and application mobility and portability. This design offers network partitioning by separating management networks and virtual desktop pool networks with an NSX-V layer-2 network.

Each specific network is part of the NSX construct in which all these virtual desktops are placed behind an NSX logical switch. Each logical switch is responsible for implementing an isolated network with its own private IP space. This isolated network is then fronted by a logical router to an NSX Edge Services Gateway appliance that provides routing to external networks as well as firewalling services. All internal east-west routing is enabled using the NSX universal distributed logical router. Using UDLR, all the virtual desktops can communicate with each other if the firewall rules permit the communication channel.

All external (north–south) connectivity is handled by an NSX Edge router, which is deployed in high-availability mode:

- One interface is connected to the external network
- Another interface is connected to a logical switch, which is also connected to the NSX universal distributed logical router.

Both the NSX Edge device and the universal distributed logical router (UDLR) run a dynamic routing protocol (such as BGP) to propagate routing information upstream to the physical network, as well as information downstream to the NSX universal distributed logical router.

The following figure shows the conceptual NSX network segmentation and the placement of management components, VMware SD-WAN, and virtual desktop components.
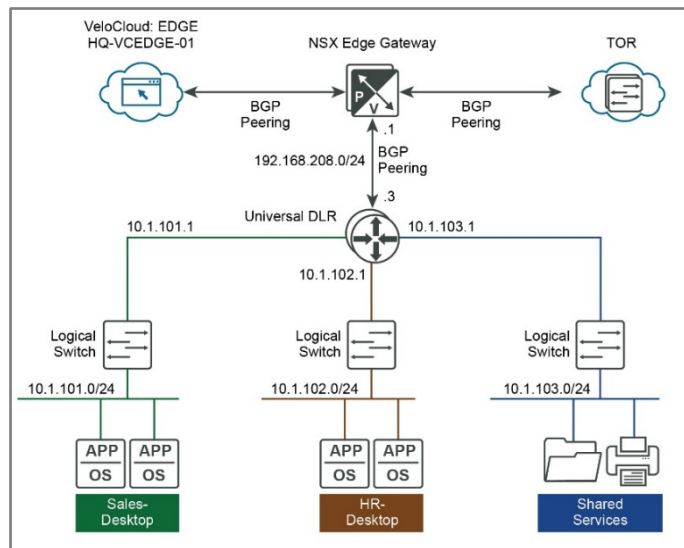
For more information about security for Hyper-Converged Solutions and VMware NSX-V, see Security for Hyper-Converged Solutions: Dell EMC VxRAIL Appliances - VMware vSAN ReadyNodes with VMware NSX-V.

NSX Configuration for this Solution

The following table describes the NSX for vSphere components and installation requirements based on the solution design described in this document, in compliance with NSX best practices.

Component	vCPU	Memory	Disk	Quantity
NSX Manager	4	16 GB	60 GB	1
NSX Controller	4	4 GB	20 GB	3
NSX ESG	Large	512 MB (Compact)	512 MB (Compact)	2

NSX DLR	1	512 MB	512 MB	2

Note: NSX ESG sizing can vary with tenant requirements. Customer implementation settings will vary depending on their environment and NSX Edge gateway and NSX DLR requirements.

High Availability of NSX for vSphere Components

The NSX Manager instances of the converged SDDC stack run on the converged cluster under the management resource pool. vSphere HA protects the NSX Manager instances by ensuring that the NSX Manager VM is restarted on a different host in the event of a primary host failure.

The NSX Controller nodes of the converged SDDC stack run on the converged cluster under the management resource pool. The vSphere Distributed Resource Scheduler (DRS) rules ensure that NSX for vSphere Controller nodes do not run on the same host.

- The data plane remains active during outages in the management and control planes, although the provisioning and modification of virtual networks is impaired until those planes become available again.

- The NSX Edge service gateways and DLR control VMs of the converged SDDC stack are deployed on the converged cluster under the Edge resource pool.

Anatomy of the Solution Environment

The environment includes the physical infrastructure, common services, and virtual infrastructure components. It also follows the design principles described throughout this document. The following table describes the hardware required for the solution environment.

Hardware	Specification
VxRail V570 (Used In HQ Data Center)	• **CPU cores**: 16 CPUs • **Processor**: Intel(R) Xeon(R) CPU E5-2630 v3 @ 2.40GHz • **Memory**: 192 GB • QTY - 4 nodes
VxRail P570 (Used in Branch Data Center)	• **CPU cores**: 16 CPUs • **Processor**: Intel(R) Xeon(R) CPU E5-2630 v3 @ 2.40GHz • **Memory**: 192 GB • QTY – 4 Nodes
Network Switch	• 2 x Dell S4148

Note: NSX ESG sizing can vary with tenant requirements. Customer implementation settings will vary depending on their environment and NSX Edge gateway and NSX DLR requirements.

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Refer to the Bill of Material later in this document for the VMware software specifications.

Solution Components

This section describes the solution components in the VMware SD-WAN for Hyper-Converged Platform.

Dell EMC VxRail appliances

VxRail appliances are jointly developed by Dell EMC and VMware. They are the only fully integrated, preconfigured, and tested HCI appliances powered by VMware vSAN technology for software-defined storage. Managed through the ubiquitous VMware vCenter Server interface, VxRail provides a familiar vSphere experience that enables streamlined deployment and the ability to extend the use of existing IT tools and processes.

VxRail appliances are fully loaded with integrated, mission-critical data services from Dell EMC and VMware, including compression, deduplication, replication, and backup. VxRail delivers resiliency and a centralized management functionality to enable faster, better, and simpler management of consolidated workloads, virtual desktops, business-critical applications, and remote-office infrastructure. As the exclusive hyper-converged infrastructure appliance from Dell EMC and VMware, VxRail is the easiest and fastest way to build a fully virtualized VMware environment.

VxRail provides an entry point to the software defined datacenter (SDDC) for most workloads. Customers of all sizes and types can benefit from VxRail, including small- and medium-sized environments, remote and branch offices (ROBO), and edge departments, as well as providing a solid infrastructure foundation for larger data centers. Small-shop IT personnel benefit from the simplicity of the appliance model to expedite the application deployment process while still taking advantage of data services only typically available in high-end systems. Larger data centers benefit by rapid deployment where a complete vSphere environment can be installed and be ready to deploy applications within a few hours of the system arriving on site. VxRail allows businesses to start small and scale without disruption. Storage is configured to meet appropriate application capacity and performance requirements.

VMware SD-WAN by VeloCloud

VMware SD-WAN by VeloCloud combines the economics and flexibility of a hybrid WAN with the deployment speed and low maintenance of a cloud-based service. It includes policy-based, network-wide application performance, visibility, and control while dramatically simplifying the WAN by delivering virtualized network services from the cloud to connect branch offices.

VMware SD-WAN by VeloCloud Edges

The VMware SD-WAN by VeloCloud appliance is a compact, thin edge device that is zero-touch provisioned from the cloud for secure, optimized connectivity to applications and data. The VMware SD-WAN Edge is also available as a VNF (virtual network function) for instantiation on a virtual CPE platform.

The VMware SD-WAN Edge with Dynamic Multi-Path Optimization (DMPO) and deep application recognition aggregates multiple links (e.g. Private, Cable, DSL, 4G-LTE) and steers traffic over the optimal links to other on-premise VMware SD-WAN Edges in branch offices, private data centers, campuses, and headquarters. This solution guide uses the VMware SD-WAN virtual appliance as the deployment model. For more information about VMware SD-WAN, visit www.velocloud.com.

VMware SD-WAN Edges provide zero touch VMware SD-WAN deployments in branches, and scalable on-premises hub deployments for headquarter and data center locations. Additionally, all the benefits of SD-

WAN (namely assured performance, security and policy control) are available directly to the doorstep of cloud SaaS and IaaS locations via VMware SD-WAN by VeloCloud Gateways. The cloud-based VMware SD-WAN by VeloCloud Orchestrator provides enterprise-wide business policy, configuration, troubleshooting, and at a glance monitoring.

VMware SD-WAN Edges are available as easy to install appliances for remote branches with a range of throughput, ports for WAN and LAN connectivity, and integrated wireless LAN. Dynamic routing enables policy-based overlay insertion for both in-line and out-of-path deployments. High availability deployments are also supported. In addition to appliance options, the VMware SD-WAN Edge is available as a virtualized network function (VNF) software for deployment on standard x86 servers, including virtual CPE devices.

VMware SD-WAN by VeloCloud Gateways

Multi-tenant VMware SD-WAN by VeloCloud Gateways are deployed by VMware SD-WAN and its partners at top-tier network points of presence and cloud data centers around the world for the full range of VMware SD-WAN benefits. VMware SD-WAN Gateways provide a scalable and distributed infrastructure with the advantages of hosted, network-as-a-service flexibility. VMware SD-WAN Gateways provide the ideal architecture for optimized access to cloud applications and data centers, as well as access to private network backbones and legacy enterprise sites.

VMware SD-WAN Orchestrator and Controllers

The VMware SD-WAN by VeloCloud Orchestrator and Controllers provides centralized enterprise wide installation, configuration and real time monitoring in addition to orchestrating the data flow through the cloud network. The VMware SD-WAN Orchestrator enables one-click provisioning of virtual services in the branch, the cloud, or the data center. Controllers collect and distribute enterprise-wide routing information, and they are distributed alongside Gateways as a service or can be deployed on-premises.

VMware NSX for vSphere

VMware NSX® Data Center is the network virtualization and security platform that enables the virtual cloud network, a software-defined approach to networking that extends across data centers, clouds, endpoints, and things. With NSX Data Center, network functions—including switching, routing, firewalling, and load balancing—are brought closer to the application and distributed across the environment. Like the operational model of virtual machines, networks can be provisioned and managed independent of the underlying hardware. NSX Data Center reproduces the entire network model in software, enabling any network topology—from simple to complex multitier networks—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 or from a broad ecosystem of third-party integrations, ranging from Next-Generation Firewalls to performance management solutions, to build inherently more agile and secure environments. These services can then be extended to multiple endpoints within and across clouds. For more information, see VMware Validated Designs for the Software-Defined Data Center.

VMware Horizon 7

VMware Horizon® 7 delivers virtualized or hosted desktops and applications through a single platform to end users. These desktop and application services—including Remote Desktop Services (RDS) hosted apps, packaged apps with VMware ThinApp®, software-as-a-service (SaaS) apps, and even virtualized apps from Citrix—can all be accessed from one digital workspace across devices, locations, media, and connections without compromising quality and user experience. Leveraging complete workspace environment management and optimized for the software-defined data center, Horizon 7 helps IT control, manage, and

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protect all of the Windows resources end users want, at the speed they expect, with the efficiency business demands.

Horizon 7 enables IT to centrally manage images to streamline management, reduce costs, and maintain compliance. With Horizon 7, virtualized or hosted desktops and applications can be delivered through a single platform to end users. These desktop and application services—including RDS hosted apps, packaged apps with ThinApp, SaaS apps, and even virtualized apps from Citrix—can all be accessed from one unified workspace to provide end users with all of the resources they want, at the speed they expect, with the efficiency business demands. As part of this solution design, we have used VMware Horizon 7 instant clone desktops for our VDI environment.

Bill of Materials

Components	Version	(Build#)
vSphere	6.5	7388607
vCenter Server	6.5	7515524
vSAN	6.6	NA
VMware NSX	6.4.0	7564187
VMware SD-WAN	3.2.0	20180409
VxRail appliance	4.5.200	7769314

Conclusion

This solution guide describes a holistic view of a data-center strategy in which:

- A HQ Data Center hosts all VMware SDDC management components, such as vCenter, NSX, and VSAN including VMware View Desktop pools.

- A branch office (ROBO) enables remote users to connect and consume resources, such as virtual desktops and SAS base applications over the overlay VMware SD-WAN secured network.

This solution integrates all the VMware key software defined data center components to enable customers to maximize the resource utilization without sacrificing the control and security of their infrastructure. VMware SD-WAN for Hyper-Converged Platform enables customers to build a scalable, secure hybrid cloud platform by keeping their capital and operational costs low.

References

For additional information, refer to the following publications:

- Dell EMC VxRail Network Guide
- Security for Hyper-Converged Solutions: Dell EMC VxRAIL appliances - VMware vSAN ReadyNodes with VMware NSX-V.
- VMware NSX for vSphere Design Guide
- Enterprise WAN Agility, Simplicity and Performance with Software-Defined WAN (Solution Brief)

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About the Author

Shree Das is an Architect in the OCTO Business Unit. Shree's focus is on the Software-Defined Data Center, Hyper-converged Platform, and other emerging technologies.