SD-WAN by VeloCloud

January 2020

Revision 01

Reference Architecture Guide

Abstract

This reference architecture guide describes VMware SD-WAN by VeloCloud and how Dell Technologies utilizes it to manage its 270 locations, leading to cost and resource savings, automated policy updates, and increased network visibility.

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Introduction

In 2016, Dell Technologies completed the acquisition of EMC Corporation for $67B, forming the world's largest privately controlled technology company. For the two companies to succeed with their collective goals, changes were needed. One of the most important was the network infrastructure.

Each company brought separate network systems, supporting hundreds of thousands of employees and billions of dollars of revenue. Both networks used a traditional WAN deployment. All internet traffic from remote sites was being backhauled to the data center across MPLS lines and then sent through firewalls to the internet.

With increased internet traffic usage from the branch sites because of increased cloud application usage, this other traffic was placing constraints on business-critical transport. With the high cost of MPLS lines, Dell Technologies started to investigate how to use cheaper broadband connectivity for its locations.

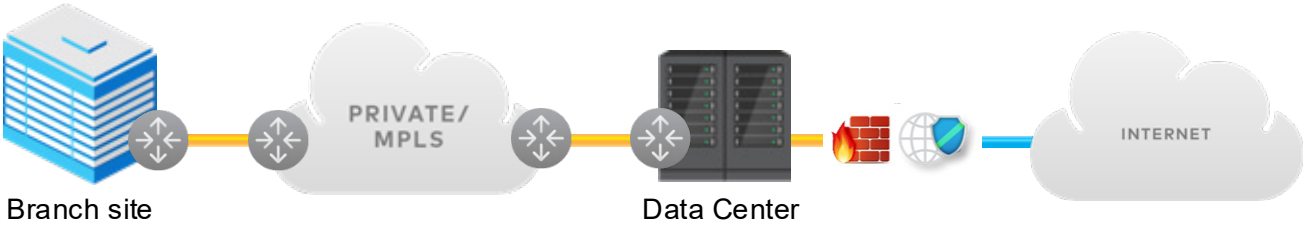

Figure 1. Legacy branch office connectivity

Software-defined WAN (SD-WAN) was chosen to unify the networks and deliver infrastructure modifications to simplify transport and increase the overall efficiency. Dell chose VMware SD-WAN by VeloCloud to meet this goal. If you design, implement, and operate enterprise solutions, this overview may help in providing an overview of the SD-WAN insertion models that are used by Dell Technologies.

VeloCloud overview

Cloud-delivered, Software-defined WAN (SD-WAN) from VeloCloud assures enterprise and cloud application performance over Internet and hybrid WAN while simplifying deployments and reducing costs.

VeloCloud provides an architecture that decouples the network control, management, and forwarding functions; enables network control to be directly programmable; and abstracts the underlying infrastructure for applications and network services. The business policies implemented by the logical overlay abstract application flows and become independent of the underlying physical transport.

As shown in the following figure, VMware SD-WAN provides a transport-independent secure overlay that enables the use of any combination of broadband Internet or MPLS links, providing the best throughput for all available connections.

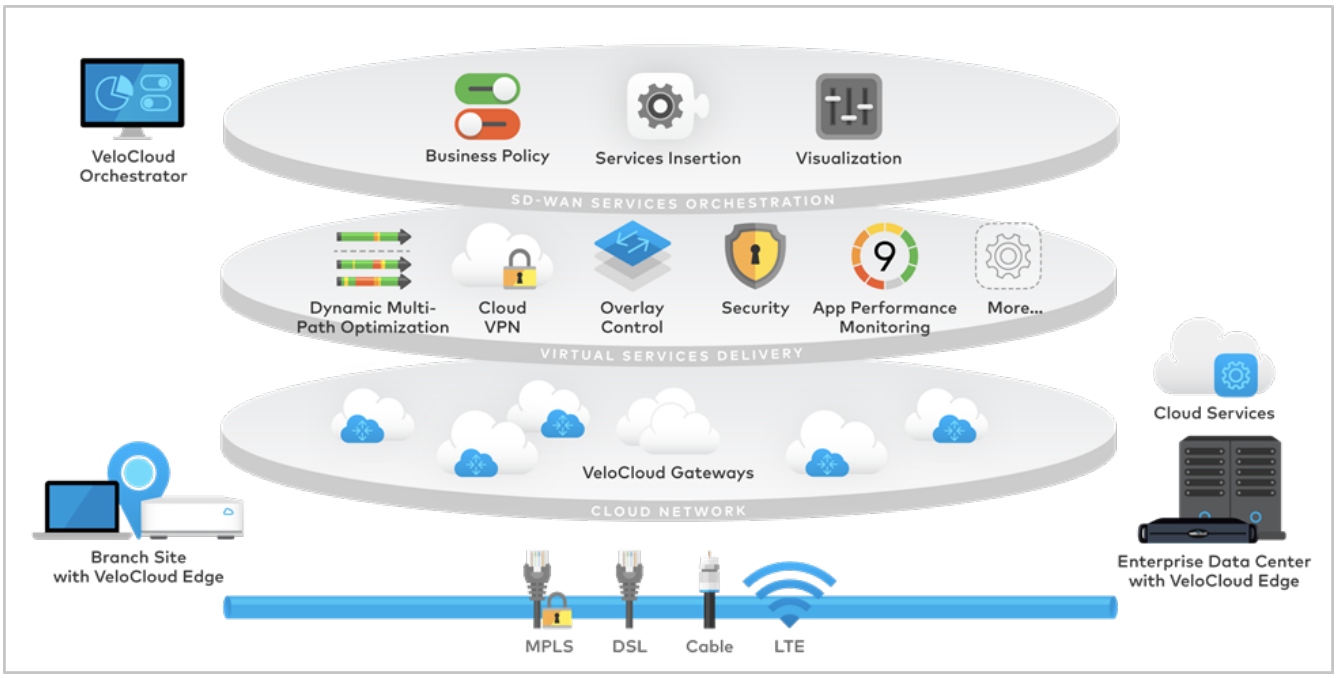

Figure 2. VMware SD-WAN services

The architecture includes three layers: Cloud Network, Virtual Services Delivery, and SD-WAN Services Orchestration.

Cloud network

Data center backhaul penalties are eliminated with a cloud-ready network, providing an optimized direct path to public and private enterprise clouds. Secure SD-WAN overlay tunnels (Edge-to-Edge or Edge-to-Cloud) enable access to enterprise and cloud applications such as traditional DC-hosted, Software as a Service (SaaS), and Infrastructure as a Service (IaaS).

Virtual services delivery

The branch office footprint is reduced with single-click, seamless insertion, and chaining of virtualized services on premise or in the cloud. The services provided by VeloCloud include DMPO, Cloud VPN, routing, segmentation, NGFW, and voice quality monitoring; or they can be offered by third-party virtual services such as cloud web security.

SD-WAN services orchestration

Low-touch branch network deployment is enabled by automation and business policy-based orchestration.

VeloCloud provides a complete cloud-delivered solution that considerably simplifies the WAN by delivering enterprise-grade performance, visibility, and control over both Internet and private networks, combining the economy of the Internet with the flexibility of the cloud. The solution enables per-packet application traffic steering between the multiple underlays without session interruption, subsecond failover, and link remediation.

VeloCloud also provides:

- Application performance optimization for virtual private instances at IaaS/PaaS/SaaS destinations
- A range of both real-time and historical connectivity and application information

- Remote diagnostics tool to confirm LAN/WAN reachability and access through the Cloud Gateway to both SaaS and external VPNs

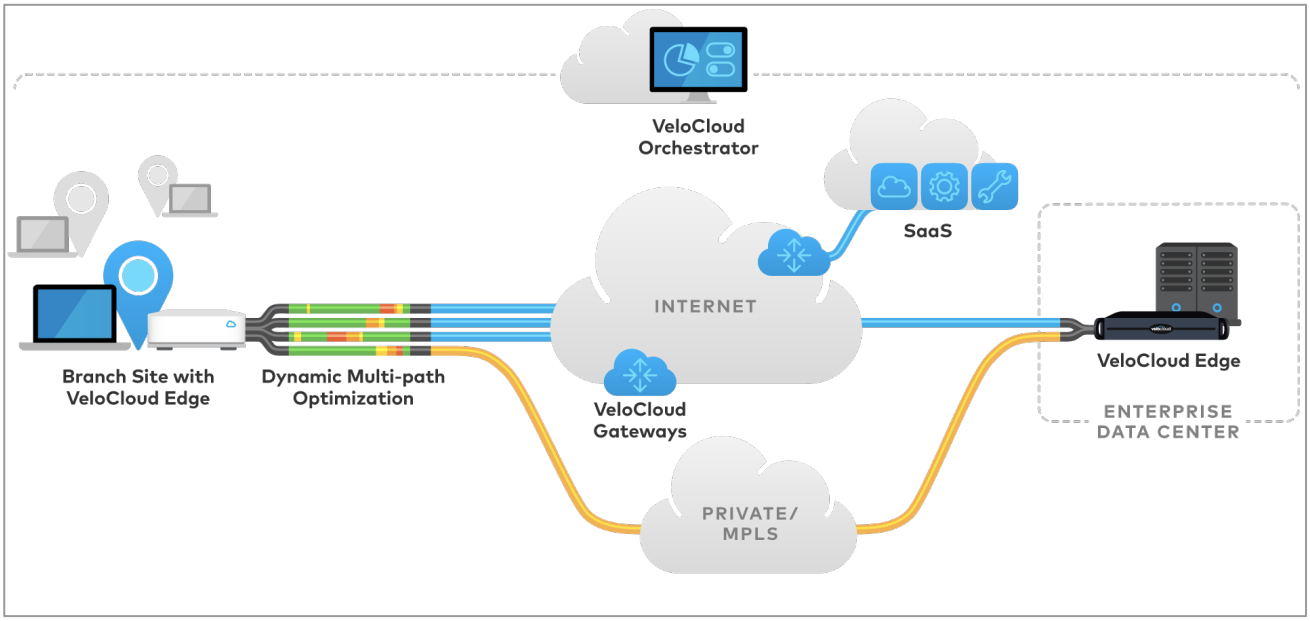

Figure 3. VeloCloud cloud-delivered components

The figure above shows the VeloCloud components. The service includes the following:

VeloCloud SD-WAN Edge (VCE)

The VMware SD-WAN Edge device provides a no-touch solution that is configured in the Orchestrator interface and can be implemented in the remote location without the help of network technologists.

This dynamic device is connected to Internet ISP or MPLS networks and balances the load across the links or provides routing received from the Orchestrator.

Connection services to traditional DC, SaaS, or IaaS are provided in a secured and managed method.

VeloCloud SD-WAN Gateway (VCG)

VeloCloud network consists of gateways that are deployed at top-tier network points-of-presence and cloud data centers around the world, providing SD-WAN services to SaaS, IaaS, and cloud network services as well as access to private backbones. Multitenant, virtual gateways are deployed both by VeloCloud transit and cloud service provider partners.

The primary function of the gateway is to perform SD-WAN control plane functions including highly scalable route distribution. Also, the gateways provide the advantage of an on-demand, scalable, and redundant cloud network for optimized paths to cloud destinations.

These gateways are deployed, managed, and maintained by VMware and are geographically dispersed around North America and other countries. They are designed to be secure, resilient, and redundant.

Each edge device, once activated, automatically discovers the nearest VCG and also connects to any other VCG needed to establish VPN and cloud connectivity. Each gateway has over 10 Gbps of peering capacity and is located at primary peering points close to content providers including Google, AWS, and Akamai.

VeloCloud SD-WAN Orchestrator (VCO)

VMware SD-WAN Orchestrator provides centralized enterprise-wide management configurations and real-time monitoring, as well as orchestrates the data flow into and through the SD-WAN overlay network. Also, it provides the one-click provisioning of virtual services across Edges, in centralized and regional enterprise service hubs and in the cloud.

Deploying VeloCloud

Multiple factors influence deployment decisions, including the makeup of a remote site, end-user requirements, and budget limitations. The first step in deploying VeloCloud is to classify the types of sites that will be using SD-WAN. The Dell EMC IT team classified the following tiers:

- Tier-0 – remote locations with employees using software-based VPN approaches. No SD-WAN technology needed
- Tier-1 – small branch offices with fewer than 50 employees. These sites rely primarily on a single internet circuit for connectivity.
- Tier-2 – branch offices with 50 to 2,000 people in each. These locations are small and would rely primarily on dual internet connections.
- Tier-3 – large campus locations, with an average of 14,000 employees in each. These are considered Centers of Excellence (CoE) and would need a minimum of one MPLS connection and two internet connections.
- Tier-4 – contact centers or data center locations. These are high-value and need high resiliency, and thus need dual MPLS and dual internet. These sites act as transit locations during and after a successful SD-WAN migration.

Note: Due to the simplicity of the locations and lack of network requirements, further details of Tier-0 and Tier-1 are omitted from the remainder of this document.

Dell EMC then evaluated the number and type of all expected applications, servers, and workloads that will transverse the WAN. Minimal network requirements were compiled, as well as how the applications interact with distributed resources across the WAN. Real-time streaming protocols such as video, voice, and high-performance databases need to be identified, marked, and prioritized over one of the available WAN connections.

In addition to the analysis performed above, each tier had further network service requirements shown in the following list:

- Tier-2 needs VoIP and basic QoS.
- Tier-3 needs VoIP, video, WAN acceleration, multicast, and extensive QoS.
- Tier-4 needs identical services as Tier3, with additional configuration complexity.

Only through this analysis could Dell EMC determine whether applications might drain SD-WAN resources or need faster speeds. Without performing a proper audit and prioritizing applications, the intelligence of an SD-WAN deployment lacks the information to make proper routing decisions.

VeloCloud makes setting policies as simple as a single click. Dell EMC defines business-level policies that apply enterprise-wide across many Edges, all through the centralized VeloCloud Orchestrator (VCO). Link steering, link remediation, and QoS are all applied automatically, based on the business policies; however, specific configuration overrides may also be employed. The VCO also supplies an enterprise-wide view and configuration of routing in an overlay flow control table, ending complex node-by-node route configurations.

Choosing the proper hardware

Before deploying VeloCloud, the proper hardware platform had to be chosen. There are two ways to deliver VeloCloud: either with a physical edge appliance, such as the Dell EMC SD-WAN Edge 3000; or deployment of the VeloCloud Edge (VCE) as a virtual network function (VNF) to the Dell EMC Virtual Edge Platform (VEP) 4600.

The Dell EMC Edge 3800, shown below, is tailored for larger deployments. Using an Intel Xeon-D 2100 processor, scaling up to 16 cores, and up to 256 GB of SSD storage, the S3000 series can handle the largest possible VeloCloud workloads.

Figure 4. Dell EMC SD-WAN Edge 3800

The VEP4600 uses the same physical architecture of the Dell EMC Edge 3800 and is an open modular universal CPE (uCPE) platform to host VNFs, such as the VCE. Additional VNFs can be deployed allowing advanced service chaining to occur without the need to send traffic outside of the appliance.

Figure 5. Dell EMC Virtual Edge Platform 4600

The choice of hardware is driven by the need to provide additional VNFs at each location. If VeloCloud is the only service insertion that is required at a location, the Edge 3800 performs marginally better because of reduced overhead of the hypervisor. In this document, the Dell EMC VEP4600 is deployed at all locations to allow for maximum expansion and growth as the network matures.

Note: See the SD-WAN Solutions Info Hub for more information about performance across all Dell EMC Edge and VEP platforms.

Choosing the proper insertion for each site

In the figure below, three locations are shown. Tier-2 is the smaller site, needing only broadband connectivity. Tier-3 is the high-value campus/branch location, needing MPLS. Tier-4 is the high-value site, and it is a data center in this example. The black lines represent Layer 2 links, allowing the circuits to be physically terminated and logically connected directly to the VCEs.

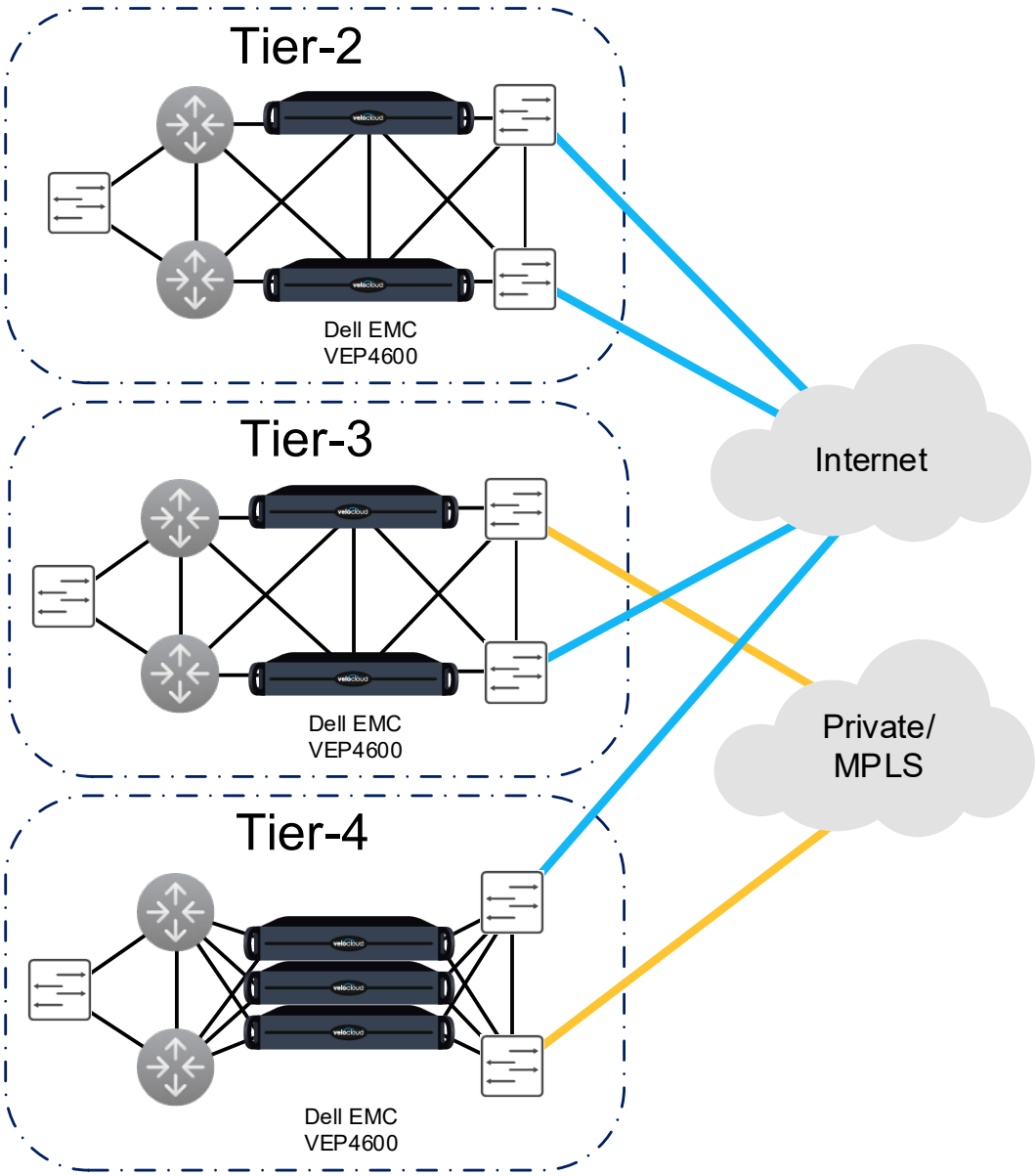

Figure 6. Example of Dell Technologies SD-WAN network

Tier-2 overview

For medium-sized branches where High-Availability (HA) is needed, configure the VeloCloud Edge (VCE) as an HA pair with BGP routing to the core switches. The same logical L3 interface is used as the next hop for the LAN side routes, and BGP is used to forward this traffic to the Dell EMC VEP4600 HA pair. To achieve subsecond failure, both of the next-hop virtual IP addresses (VIPs) on the switches stay the same when a VCE failover event occurs.

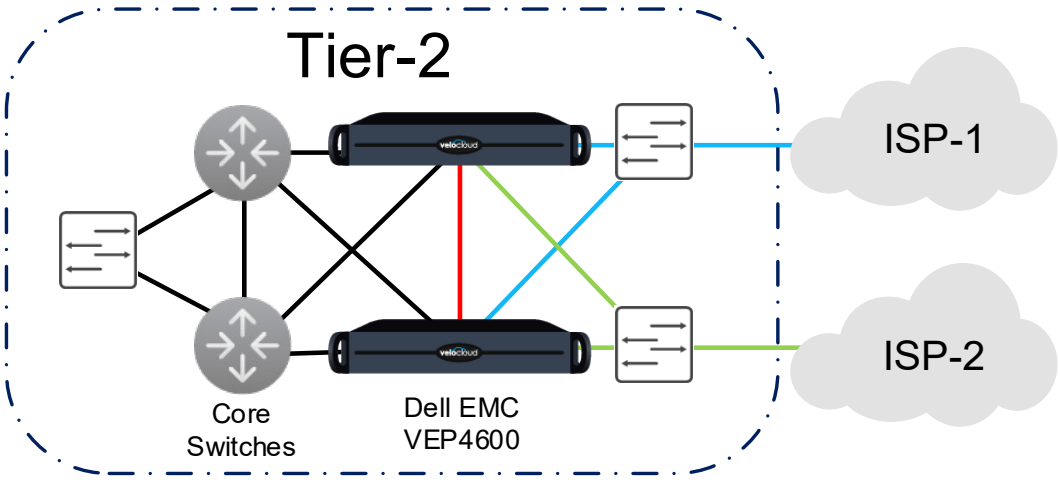

Figure 7. Tier-2 topology, dual internet circuits

VeloCloud high-availability allows subsecond failure when an appliance is offline, which allows hitless upgrades. The edges negotiate the active and standby roles based on total active links. The standby edge blocks all ports except the failover link (typically port 1). State information, heartbeat, and surrounding status (for example, WAN and LAN port status) is communicated across the failover link. The same MAC addresses are used on both platforms, enabling the subsecond failover, similar in concept to any first-hop redundancy protocols.

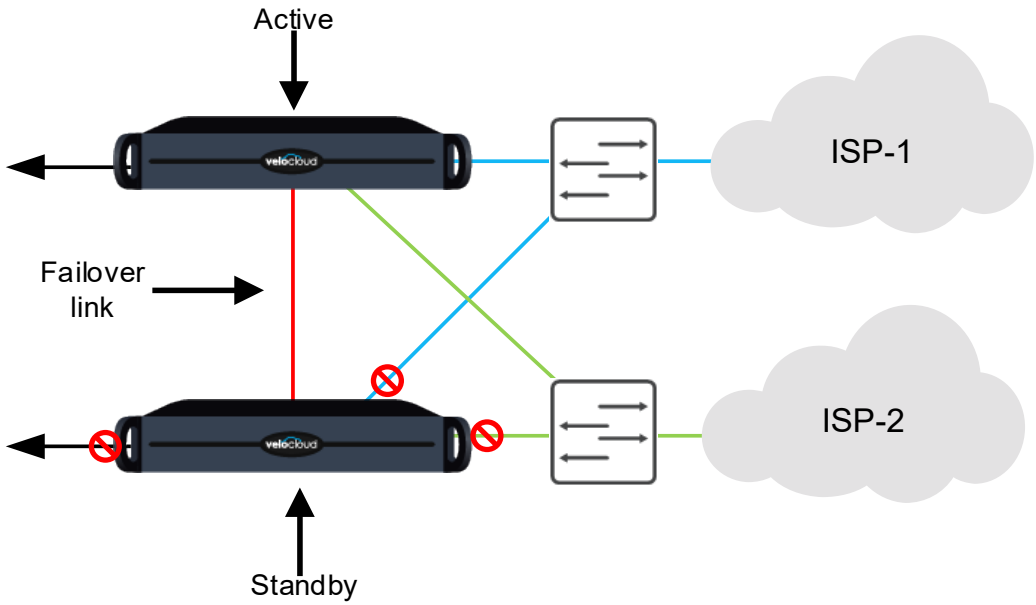

Figure 8. VeloCloud High-Availability overview

Tier-3 overview

The figure below shows the deployment architecture of the Dell EMC SD-WAN Tier-3 site. A hybrid SD-WAN site design is one where a site has an Internet circuit and at least one MPLS connection. This design topology can apply to a typical enterprise site with only an MPLS circuit that is migrating to SD-WAN. VeloCloud is agnostic to the circuit type and uses all available connections to provide load balancing.

In this design, a pair of VCEs, like in Tier-2, operate as an HA pair. All internet connections are logically connected directly to VeloCloud, while physically terminated to the WAN aggregation switches. Each circuit is isolated by a separate VLAN and trunked between the switches and the VEP4600. VeloCloud is agnostic to circuit types and handles each type identically. Its built-in telemetry can determine which interface would be best for a given traffic flow.

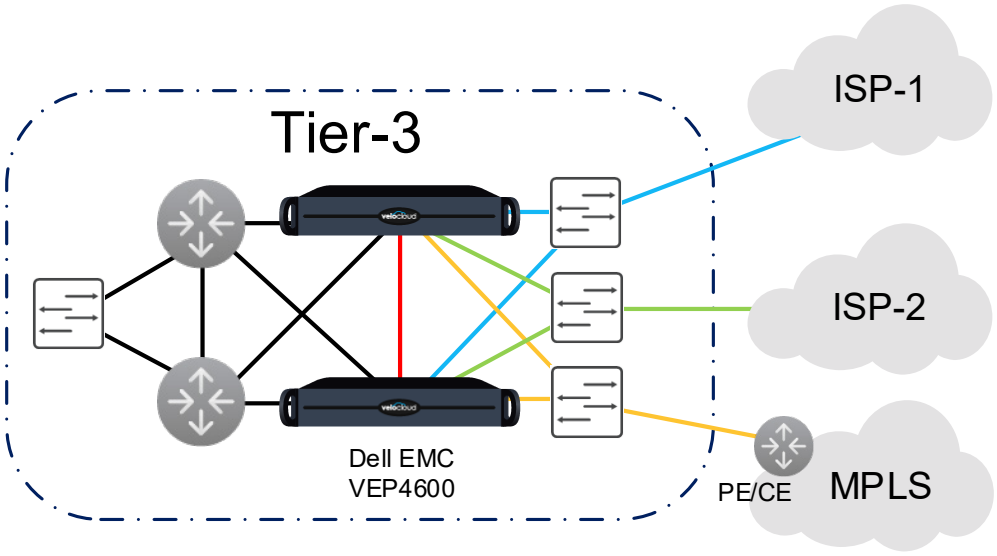

Figure 9. Tier-3, dual broadband and MPLS site

Security options for internet traffic

Based on Dell Technologies business policies, some traffic from these sites must remain on the MPLS links. Specific application streams can be backhauled to the DC allowing additional security checks enforcing. Other business policies can be defined to utilize available bandwidth from both MPLS and Broadband for Internet backhaul.

VeloCloud can route traffic using four models:

- Prefer the Internet link unless it is down, then use the MPLS (SD-WAN reachable)
- Drop internet traffic if it cannot be backhauled
- Failback to direct internet if it cannot be backhauled
- Direct to internet by default, and backhaul as backup

Tier-4 overview

The following figure shows the deployment architecture of a Dell EMC SD-WAN Tier-4 site. As you may recall, Tier-4 sites are contact or data centers. These sites have multiple broadband and MPLS connections at each site. Also, Tier-4 locations act as transit sites

for all other sites. Dell EMC backhauls traffic, based on business policies, back to a regional data center before routing the traffic to its next destination. Additionally, these sites act as transit sites for reaching legacy, non-VeloCloud sites, affording Dell EMC the opportunity to gradually migrate to an SD-WAN solution.

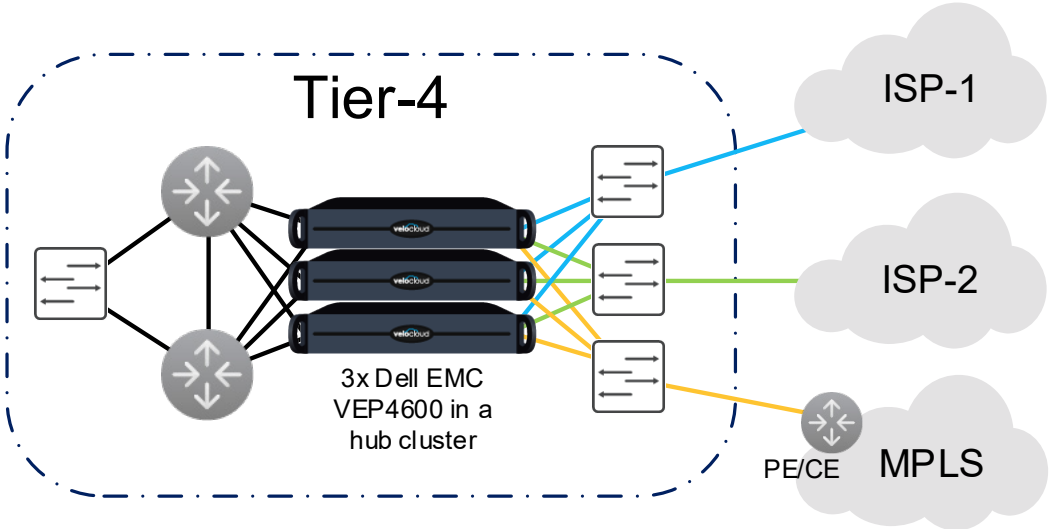

Figure 10. Tier-4, dual internet circuits in HA with redundant MPLS circuits

In a VeloCloud SD-WAN solution, clustering is a feature to logically group multiple active/active SD-WAN hubs in the same location so that they can operate as one logical unit when configured as the hub for branch VCE profiles. The two main purposes of hub clustering are horizontal scaling and redundancy. When the bandwidth or tunnel requirements at a hub location exceed the capability of a single hub edge, multiple hubs can be configured as a cluster to horizontally scale up to the required bandwidth and number of tunnels.

The other purpose of hub clustering is to provide redundancy for a hub location to minimize single point of failure. It is recommended to deploy at least *n* + 1 hubs in a cluster, assuming *n* is the minimum number of hubs that are needed to meet the bandwidth and tunnel requirements. Hub clustering is recommended over HA for data center deployment in most cases.

More information

Terminology

The following table provides definitions for some of the acronyms that are used in this document.

Table 1. Terminology

Acronym	Acronym Meaning	Description
VCO	VeloCloud Orchestrator	Management plane component for the VMware SD-WAN solution
VCG	VeloCloud Gateway	Control plane component of the VMware SD-WAN solution

Acronym	Acronym Meaning	Description
VCE	VeloCloud Edge	Data plane component of the VMware SD-WAN solution
	WAN Overlay	SD-WAN tunnel from VCE to VCG and between VCEs
NVS	Non-VeloCloud Site	Sites and subnets that are connected to the SD-WAN solution using standard IPsec tunnels from the VCG
DMPO	Dynamic MultiPath Optimization	VMware SD-WAN proprietary techniques that perform link monitoring, dynamic application steering, remediation, and application-aware QoS on the overlay tunnels
DCI	Data Center Interconnect	The high-speed link between data centers that provides network connectivity and capacity scaling

References

The following Dell EMC documentation provides additional and relevant information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your Dell EMC representative.

VMware SD-WAN by VeloCloud documentation

- *Dell EMC Networking SD-WAN FAQ*
- *Install Virtual Edge on VMware ESXi*
- *SD-WAN Efficiency and Automation to Largest Privately Held Corporate Merger*

Dell EMC Edge and VEP documentation

- *VCE 3000 series documentation*
- *VEP4600 documentation resource*
- *VEP4600 VMware Compatibility Guide*

We value your feedback

Dell EMC and the authors of this document welcome your feedback on the solution and the solution documentation. Contact the Dell EMC Solutions team by email or provide your comments by completing our documentation survey.

Note: For links to additional documentation for this solution, see the Dell EMC SD-WAN Solutions Info Hub.