

The Economic Advantages of Open and Web-Scale Networking

Running Cumulus Linux network operating system on Dell EMC open networking switches

Summary

By the year 2020, it is expected that over 40% of enterprises will have a web-scale networking initiative.¹ This whitepaper will cover the challenges with traditional networking, the definition of open, web-scale networking technology, examples of how this technology can improve your data center networks and the benefits that organizations enjoy when making the switch.

Cumulus Networks and Dell EMC have seen benefits like:

- Reduced CapEx by 1/3 when comparing to vertically integrated options
- Increased operational efficiency by reducing time to production by 95%
- Reduced OpEx up to 75%, by optimizing operator-to-switch ratio

¹ Source Gartner Group

1. The enterprise IT challenge

Enterprise organizations are dealing with highly dynamic computing, storage and networking needs at a greater capacity than ever before. The primary factors driving the industry are mobility, cloud computing, big data and the Internet of Things (IoT). However, the static nature of the traditional network is not designed to address the contemporary data center network and computing needs of evolving businesses. These new dynamics have brought about a shift, introducing virtualized network traffic patterns, resource pooling, cloud and the need for server-like automation. Additionally, this shift in dynamics has led to modern data center network environments which are designed to simplify and automate physical switch deployments.

The current standard networking industry looks much like the proprietary computing market of 40 years ago, where a small number of industry players produced vertically-integrated solutions with software and hardware that were single-sourced. This practice led to a proprietary industry culture where innovations were stifled and operations were fragile, complicated and expensive.

"[The] new era of networking is defined by disaggregation, software & virtualization, and open source." — Guru Parulkar, Executive Director, Open Networking Research Center

While IT organizations have attempted to meet these new dynamics using the legacy network infrastructures mentioned above, this approach has resulted in increasingly complex deployments that make network management and maintenance even more burdensome and costly.

According to a recent report from Delphi Technology, many organizations are moving away from legacy platforms to more modern vendor supplied solutions.² This trend is based on increasing support and maintenance problems with the current legacy systems.

In some cases the legacy system's technology is a few generations behind resulting in inefficient processes and management. Another example is when technical staff leaves the company and the organization then struggles to maintain a system that many IT staff are unfamiliar with. A final example is the astronomical costs of some support agreements when a vendor is charging more for the effort required to upkeep aging technology.

A key contributor to IT's inability to move quickly is the condition of the existing network infrastructure. While other systems within the data center are accelerating and adopting new technologies, the popular status of networking has remained traditional and dated — no longer representative of the modern data center. Many of today's proprietary networking vendor solutions maintain a vertical "black box" approach where hardware and software are closely joined, aimed at locking in customers.

²http://www.riskandinsurance.com/wp-content/uploads/2015/09/Delphi_Opportunity-Cost-of-Retaining-Legacy-Systems.pdf

"The only way to stay ahead of this growth curve is software." — John Donovan, Chief Strategy Officer and Group President, AT&T Technology and Operations

Fortunately, innovations in networking are rapidly changing the industry. As a result, new, innovative, open solutions to these challenges are available. This is how open networking was born.

The next section will take a closer look at some data center networking advances that will enable enterprise organizations to improve their network infrastructures while also reducing cost

2. The emergence of new technologies in the data center

A new approach to networking operating systems

As more and more organizations are moving towards building a private or hybrid cloud environment, efficiency and scalability of the data center are becoming more important. Using open networking methods, an organization can build a scalable data center just as efficient as the data center giants like Facebook and Google. These principles are often referred to as “web-scale IT” or “web-scale networking”.

By using open ONIE compatible hardware, organizations can choose a network operating system that is built for scalability and optimization. Businesses can leverage existing tools, like those for automation, by porting applications from their compute to networking environment, they can unify the stack on Linux and standard topology, and they can optimize the number of operators per switch.

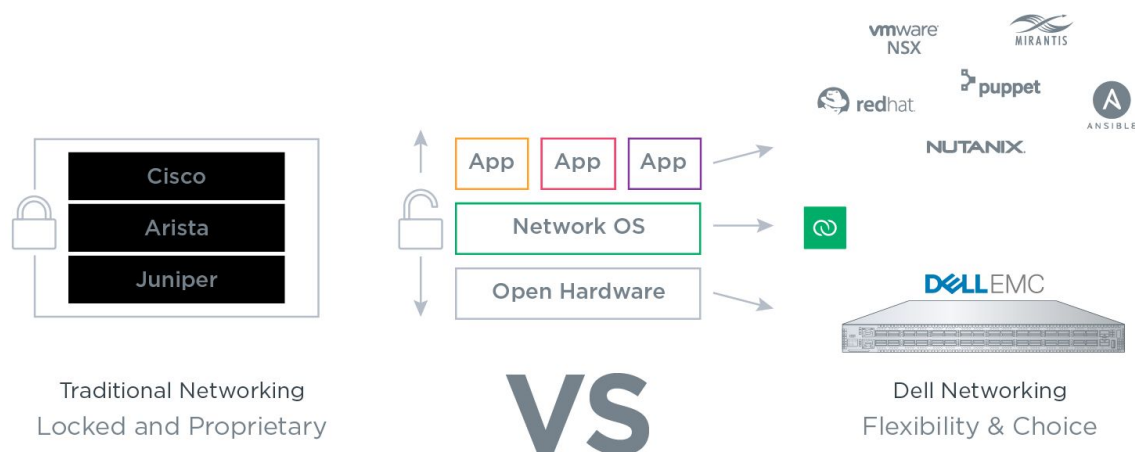


Figure 1: Network disaggregation

Spine-leaf fabric methodology

In traditional data center networking, engineers faced a fundamental challenge: in order to increase scale and redundancy, they were required to add multiple tiers, devices and physical links. Because of these extra links, Spanning Tree Protocols (STP) had to be configured in order to ensure a loop-free topology between all of the data center switches. These protocols were required for stability, but also caused more complicated and expensive architectures with several downsides: unused bandwidth, slow convergence and increased management complexity.

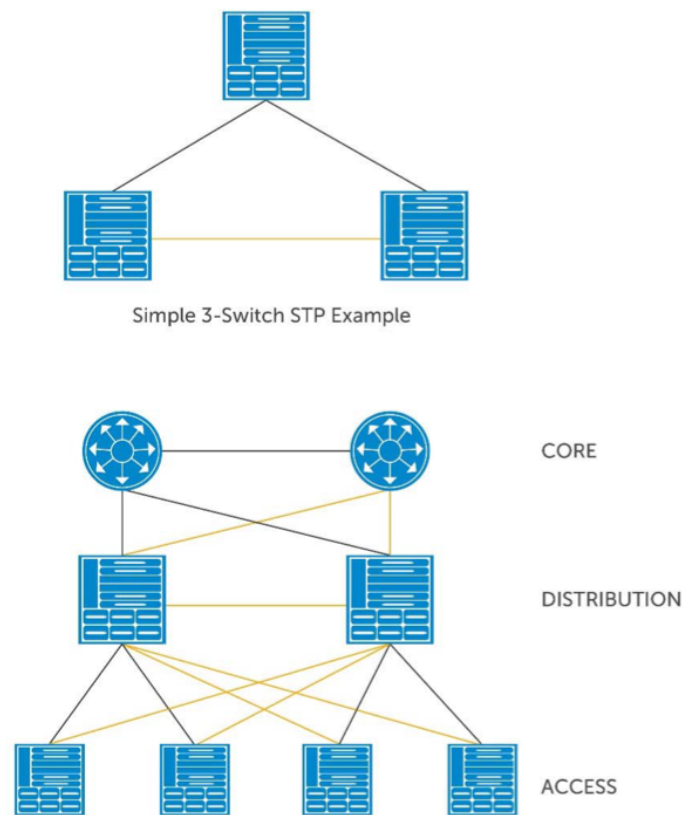


Figure 2 - Legacy spanning tree examples

Due to these complexities and increasing costs, other options emerged, and the industry quickly shifted away from the "tiered" topologies to Clos-based fabric topologies, or spine-leaf fabrics. These data center fabrics are optimized for today's modern virtualized data centers, which are experiencing increasingly heavy east-west traffic patterns based on the new dynamics discussed earlier. This fabric design flattens the physical topology, provides a predictable switch-to-switch latency, and largely removes the risk of network loops.

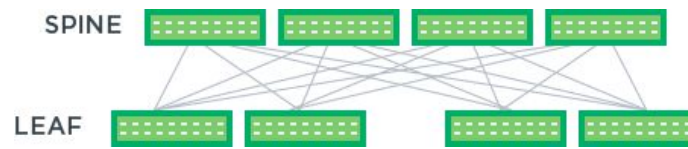


Figure 3 – Spine-leaf topology

Benefits of open, web-scale networking

Web-scale networking using open networking principles and spine-leaf fabrics, originally popularized by hyperscale data-center operators such as Google, Facebook, and Amazon, is an increasingly popular design for enterprise organizations due to the elegant scale-out properties, flexibility, resiliency and attractive cost dynamics:

- **Scale-out:** With open networking, scalability is affordable and easy with more switches per operator, better automation and greater efficiency.
- **Resiliency:** As there are a large number of parallel active links, several links can fail before connectivity across the system as a whole is materially impacted.
- **Flexibility:** Open networking offered flexibility in number of ways. From choice of OS and hardware to the ability to write custom protocols and applications to meet business needs.
- **Cost:** Compared to proprietary and expensive designs, open hardware is less expensive and open software maximizes efficiency to have an even greater impact. They provide a low latency non-blocking solution, allow for oversubscription and can be swapped out easily.
- **Technology:** With an open, disaggregated environment, technology is innovated and updated faster, allowing businesses to react to industry changes without breaking contracts or relying on one, sole vendor.

Dell EMC and Cumulus Networks changing the industry

Dell EMC and Cumulus Networks were both early pioneers in data center networking. Dell EMC's Active Fabric solutions employ Clos spine-leaf architectures with open networking switches. Dell EMC offers a family of switches which maximizes customer choice, flexibility and innovation at any scale.

Cumulus Networks offers an operating system built for scale and efficiency. By deploying a Dell EMC open networking switch with Cumulus Linux, the open network operating system offered by Cumulus Networks, businesses can build a unified Layer 3 fabric across the network. The next section of this paper will discuss how Dell EMC and Cumulus Networks are shaking up the market with our industry-leading open networking solutions.

3. Dell EMC & Cumulus Networks changing Open Networking initiative

Together, Dell EMC and Cumulus Networks are transforming the networking industry by disaggregating the network stack and bringing smarter hardware and technology to the switch.

As proprietary mainframes and mini-computers from companies like IBM and Digital were replaced with commodity-based x86-based servers, the computer industry experienced tremendous innovation, technology velocity and cost reduction.

The decoupling, or disaggregation, of the operating system (OS) from the computing hardware allowed consumers the freedom to select the best and most efficient hardware and software components at each layer, while also customizing solutions to best meet their strategic business objectives and cost requirements.

Unfortunately, despite the adoption of industry-standard data center networking protocols such as Ethernet, the networking industry had remained stuck in the 1980's proprietary era, where switches from several major networking vendors are comprised of locked-in hardware/software stacks that are not interchangeable with other vendor offerings.

Dell EMC's vision follows their earlier success as a pioneer in disaggregating computing hardware and software, offering an open data center network ecosystem in which organizations can pick and choose from a selection of innovative, industry-standard network applications, network operating systems and network hardware. Cumulus Networks' solution, Cumulus Linux, offers pervasive networking-focused Linux distribution based on Debian (Jessie) that is designed for data center top-of-rack and aggregate layer switches.

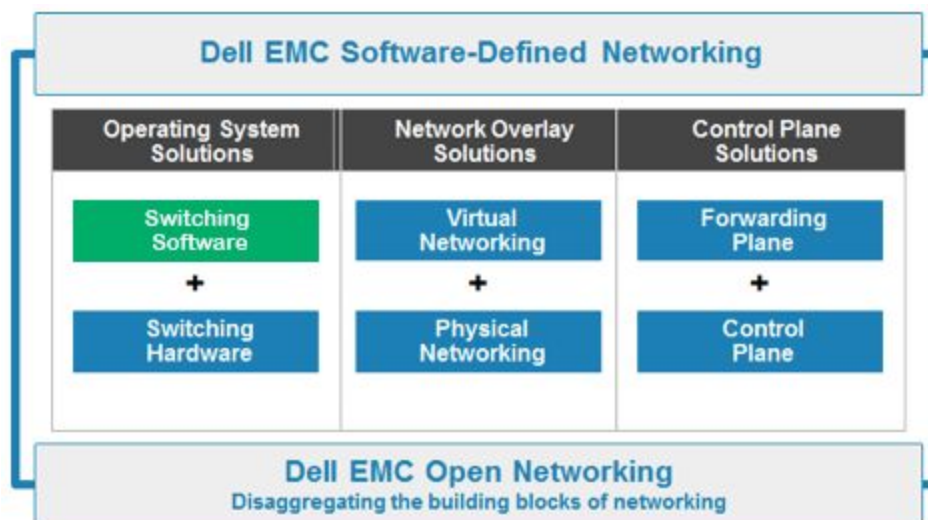


Figure 4 – Dell EMC & Cumulus Networks Open Networking

The architecture of Cumulus Linux is designed to be efficient and scalable. In the case of Cumulus Linux, the networking model is the Linux kernel. The kernel holds multiple routing tables for both policy routing and virtual-routing-forwarding, the arp/neighbor table, the bridges, the interfaces, the packet filtering (ACLs), redirections (SPAN/ERSPAN), buffering, bonding, VLANs — everything.

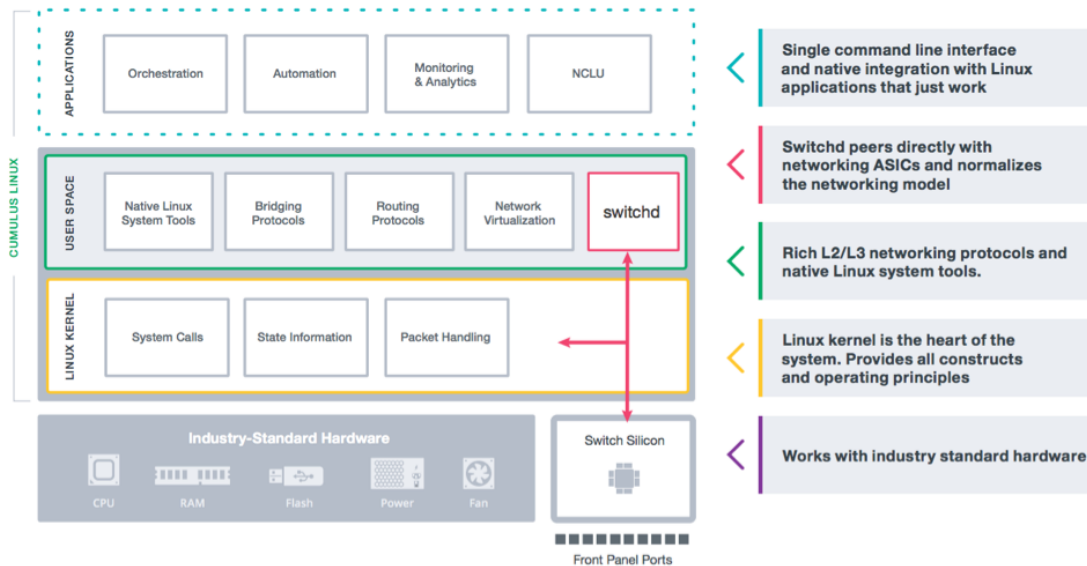


Figure 5: Cumulus Linux architecture

Configuration and Management in Cumulus Linux are layered on the kernel networking model (interacting with the Netlink bus) as well as various operational file systems such as /proc and /sys. This layering allows almost any Linux tool to be leveraged for configuration and management. Cumulus Linux includes traditional user space tools like iproute2, brctl, bridge, iptables, etc., as well as Cumulus Networks authored tools such as ifupdown2, NCLU, and PTM that are layered on these baseline tools.

This open approach enables businesses to simplify their data center networking through complete disaggregation, including disaggregating the operating system from the hardware, disaggregating the virtual network from the physical network, and disaggregating the control plane from the data plane.

Dell EMC and Cumulus Networks enable organizations to tailor their data center networks to specific applications within their organization. Our disaggregated-networking model has disrupted the traditional proprietary networking paradigm: we give organizations an open alternative for their unique needs with a growing open networking ecosystem of solutions and partners.

Both Dell EMC and Cumulus Networks truly believe that our open network solutions stimulate rapid innovation by helping our customers achieve unprecedented levels of flexibility and operational efficiency. These solutions also help minimize the time and effort required to design,

provision and manage networks; enable IT managers to leverage open-source, off-the-shelf or custom tools; and provide expertise to help reduce costly engineering overhead.

In the next section, we'll take a closer look at some management challenges when deploying fabrics in the data center and how Dell EMC and Cumulus Networks offer both our own and 3rd party partner solutions to alleviate these challenges.

4. Simplified management of data center fabrics

Since their popularization five years ago, one of the key challenges with data center spine- leaf fabrics has been their complex management. When using legacy network management technologies, even a simple spine-leaf fabric involves complex control protocols. As a result, outside of the hyperscale data centers, this exciting fabric network topology has seen slow adoption. Let's review two solutions that simplify management of the fabric.

Cumulus Linux

Cumulus Linux from Cumulus Networks provides data center operators the entirety of the native Linux experience and vibrant ecosystem of applications. Leveraging the existing open source and commercial Linux applications and toolsets enables operators to manage the network in the same seamless workflow as their Linux server. With examples on how to incorporate popular Linux management and DevOps tools like Puppet, Chef, Ansible, CFEngine, or SaltStack, this approach to spine-leaf fabric management is intended for IT shops looking to fold networking into their server management tool chains.

The following sections list a few examples where innovation, made possible by Dell EMC Open Networking and Cumulus Networks, provides the advantages of spine-leaf fabric design and web-scale networking deployed by leading technology companies and service providers to enterprise organizations on a much broader scale.

Example 1: Cutting capex, opex and deployment times with Cumulus Linux

Cumulus Networks takes a unique approach to solving the deployment and management challenges of the spine-leaf fabric. Leveraging off-the-shelf Linux-based configuration management tools, monitoring software and DevOps frameworks that data center system administrators already use, all help reduce the months and weeks of deploying network configurations to minutes. Additional advantages include:

- Ease of deployment
- Enforcing network configuration policy
- Common set of tools across the data center
- Ideal for OpenStack, Hadoop as well as traditional network designs
- Interoperable with existing network infrastructure
- No controller needed, uses traditional routing protocols network engineers understand
- Massive scale, battle-tested network designs and award-winning support

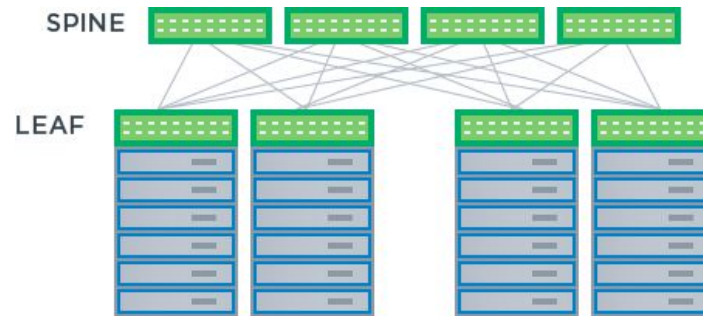


Figure 6: Leaf-Spine architecture

Using the same requirements from above, the following chart highlights the advantages a Cumulus Networks and Dell EMC Open Networking solution would deliver.

	Cumulus Linux	FabricPath
Configuration management points	1	44
Language extensibility (Bash, Perl, Python, Ruby)	Yes	No
Unnumbered interfaces (BGP and OSPF)	Yes	No
Native DevOps tools support (Ansible, Chef, Puppet, Salt)	Yes	No
Native Linux troubleshooting (scamper, mtr, iperf, ping, traceroute)	Yes	No
Native Linux tools for monitoring (Nagios, Ganglia, influxdb, collectd)	Yes	No
Full interoperability with other vendors	Yes	No
Variety of methods to configure Host to ToR (VLAN Trunks, MLAG VXLAN, RoH, Anycast)	Yes	No
Multi-tenancy	Yes	No
Rack units	20	44
Power (Watts)	5233	19020
BTU/HR	17858	57040

Table 1: Cumulus Linux comparison chart

Savings with Dell EMC and Cumulus Networks:

- 55% on space
- 72% on power
- 69% on cooling
- 57% on networking TCO³

Example 2: Open and software-defined networking for VMWare private clouds

Dell, EMC VMware, and Cumulus Networks share the same vision that data centers can be more agile and flexible when defined in software, and not hardware-based. These three companies are working together to help enterprises and service providers provide their users cloud functionality. In today's cloud focused IT environment, customers expect self-service, fast provisioning and the ability to create custom topologies.

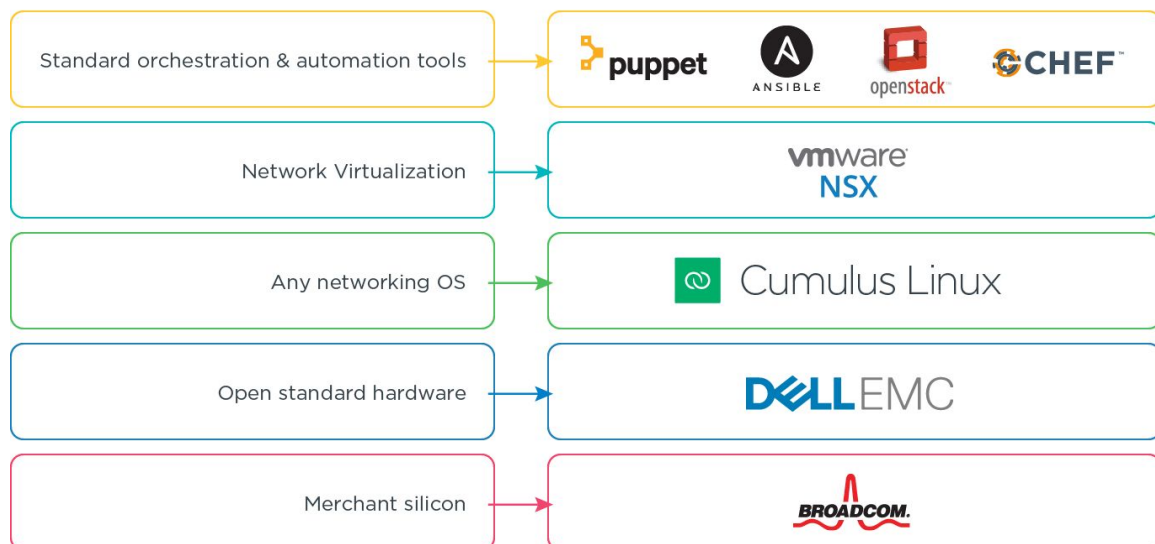


Figure 7: Dell EMC, VMware and Cumulus Networks solution

Within the software defined data center (SDDC) customers can provision physical and virtual networks, then deploy new applications within minutes. These solutions significantly simplify IT operations and improve IT response time.

As companies move to this new open networking paradigm of choice, one key consideration is the testing and support of the combined products. A solution leveraging Dell EMC, VMware and Cumulus Networks helps reduce customer risk by testing and verifying solutions and working together in a collaborative support mode. This includes testing and certifying Cumulus Networks' operating system on a variety of Dell EMC platforms that range from 1G to 100G speeds. When meeting requirements for integrating legacy databases or L4-7 applications on a VMware cloud, the Hardware VXLAN Gateway from Dell EMC and Cumulus provides a certified, tested and supported solution.

³ Statistic based on Dell EMC's research of customer experiences using Dell EMC Switches.

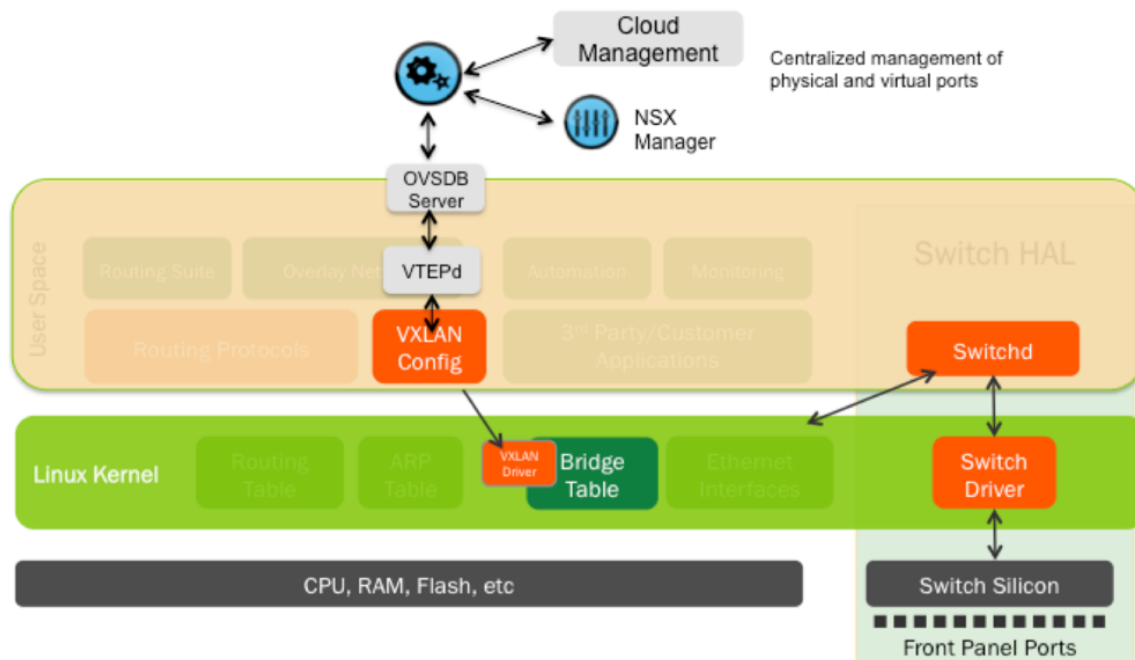


Figure 8: Cumulus Linux and Dell EMC Hardware VLAN gateway for VMWare NSX

Bringing together VMware software with Cumulus Linux on Dell EMC networking switches enables:

- An integrated solution stack with the intelligence distributed in software without vendor lock-in
- A simple support model for customers across all solutions: hardware, software, compute, network and storage
- Lower total cost of ownership (TCO) with the increase in operational efficiencies and capex gains. Potential cost savings of up to 57%.⁴

⁴ Statistic based on Dell EMC's research of customer experiences using Dell EMC Switches.

5. Conclusion: the benefits of an open networking ecosystem

Traditional networking IT deployments leveraging proprietary, vendor-locked-in solutions, obsolete software and hardware and antiquated certification processes are expensive, inefficient and inflexible. Continuation of these processes will result in slow and expensive solutions that impede an organization's ability to improve services and quickly respond to ever-changing needs and regulations.

The earlier use cases provide just a few examples of what Dell EMC Open Networking and Cumulus Networks disaggregation can enable. Further opening of the data center network for additional software will allow for many additional possibilities such as:

- Network function service chaining
- Controller-less IP fabrics
- Container optimized networking
- Hybrid/private cloud orchestration

Similar to how virtualization changed the computer industry, Dell EMC's disaggregation and open networking architectures have the potential to change the networking landscape forever. Dell EMC and Cumulus Networks are assisting enterprise organizations to seamlessly migrate to a far simpler, open and innovative model of business. Doing so will enable enterprise IT departments the ability to select state-of-the-art solutions at every layer, resulting in:

- Lower opex by up to 75% and capex by 1/3
- Improved operational efficiency by leveraging automation
- Improved service delivery times by increasing operator-to-switch ratio
- Reduced time to production by up to 95%
- The ability to remain flexible to adopt new innovations

To learn more about our open networking solutions, details of the comparisons data or methodology used, please contact your local Dell EMC representative or visit Dell.com/networking or a Cumulus Networks representative at cumulusnetworks.com/contact.

About Cumulus Networks

Cumulus Networks is leading the transformation of bringing web-scale networking to enterprise cloud. Its network switch, Cumulus Linux, is the only solution that allows you to affordably build and efficiently operate your network like the world's largest data center operators, unlocking vertical network stacks. By allowing operators to use standard hardware components, Cumulus Linux offers unprecedented operational speed and agility, at the industry's most competitive cost. Cumulus Networks has received venture funding from Andreessen Horowitz, Battery Ventures, Sequoia Capital, Peter Wagner and four of the original VMware founders. For more information visit cumulusnetworks.com or follow [@cumulusnetworks](https://twitter.com/cumulusnetworks).

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