



Software Defined Networking

A Dell Point of View

The networking industry has operated for years in a closed, mainframe-like state where the consumer's only option has been a 'big-iron' approach; working with a single vendor that controls all aspects of network operation from the hardware to the operating system to applications and features. As a result, innovation in the networking industry has become stifled; operations remain fragile, complex and expensive.

Today, the Software Defined (SDN) and Open Networking movements are presenting new, innovative approaches to solve key enterprise challenges. This paper provides an overview of Dell's point of view on SDN and Open Networking, offering guidance on how to prepare an optimal technology strategy with the business, technical and operational benefits of these powerful emerging paradigms.

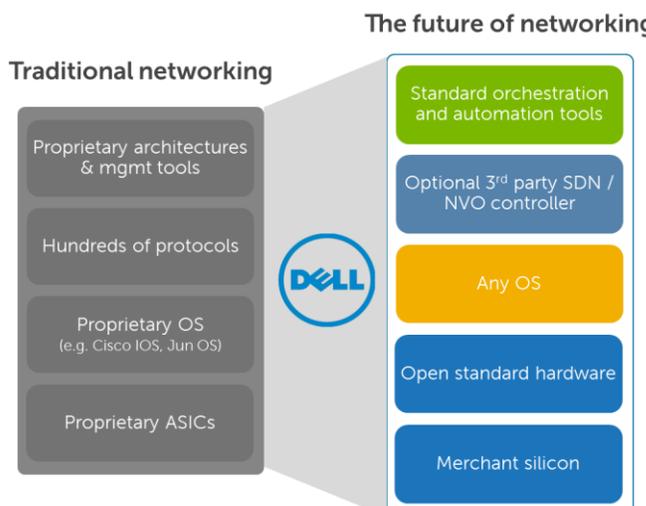
Welcome to the Open Networking revolution

Networking's closed legacy has prevented the emergence of the type of robust independent software industry that today solves countless business challenges in open x86 ecosystems. The closed mainframe industry demonstrated that proprietary ecosystems limit entrepreneurship and stifle the tremendous innovation potential that arises from open ecosystems and value chains.

For the first time, networking technologies are being freed from proprietary strangleholds and open networking hardware and software ecosystems are emerging. These factors have resulted in a hotbed of rapid innovation as entrepreneurship and the principles of capitalism take hold and uproot the closed and proprietary legacy of the networking industry, unleashing a wave of new economic benefits, innovation and opportunities.

To take advantage of the full benefits that open networking and SDN can deliver requires looking at the networking industry

Dell—Fueling the Open Networking revolution



through a new lens — no longer looking to a single vendor to solve all business challenges for all customers across all industries. The open x86 server ecosystem provides enterprises with the valued choice to select a preferred hardware vendor, preferred OS vendor and the ability to choose from a vast array of independent software solutions that best meet the strategic needs of their business. Dell has enabled networking consumers to take advantage of this powerful model with their choice of supported operating systems on select models of Dell's industry-leading hardware portfolio*.

Dell is the first and only global technology provider that offers our customers their choice of network operating system and technology architecture to best meet the unique needs of their business. Our Open Networking¹ solutions are aligned with The Open Compute Project and provide the Open Networking Install Environment, enabling our customers to choose between supported operating system choices including Dell Networking Operating System, Cumulus Linux™ and Switch Light OS™/Open Network Linux. This model delivers access to the rapidly emerging new innovations now available through open software ecosystems, all with the stability and assurance of Dell's service and support, and the breadth and power of our global supply chain.

SDN: The journey begins with the right hardware

The foundation of an SDN strategy begins with next-generation industry-standard hardware. Dell was among the first leading providers to offer "cloud-class" line-rate, dense and efficient networking hardware built on with industry-standard chipsets and components — a model that the largest networking vendors have just begun to follow.

Dell's hardware portfolio leads the industry in efficiency, density and performance and is optimized for next-generation leaf-spine and flat architectures. Dell's own networking solutions combined with our open networking partners' advanced offerings deliver the broadest range of next-generation network and SDN frameworks, ensuring investment protection, direct access to open networking innovations and true freedom from proprietary lock-in.

A powerful, flexible and adaptable model

When planning for SDN, enterprise IT organizations generally do not have the benefit of a "greenfield" deployment model and need to manage complex legacy requirements while evolving their operations toward newer models in a cost-effective manner without disruption to existing services and operations.

The resulting strategic impact is that enterprise architects need to plan for and build a flexible and adaptable infrastructure that can deliver newer services and support for new applications immediately while providing ongoing support and improvements for legacy applications and infrastructure.

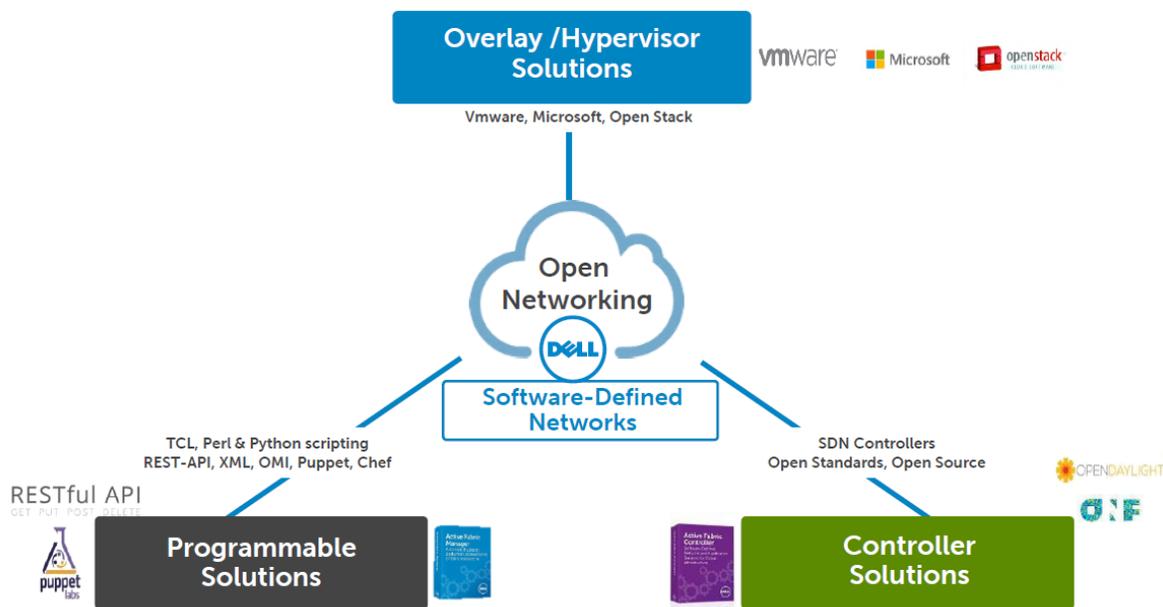
¹ Open Networking is available only on select platforms, visit [Dell.com/Networking](https://www.dell.com/networking) for more details

Dell Networking Operating System (OS9) delivers a best-in-class network OS that includes an industry-standard command-line interface, ensuring that Cisco-trained networking-staff can immediately be comfortable and productive. However, behind the scenes of the familiar and comfortable CLI, OS9 packs a powerhouse of next-generation automation, programmability and SDN capabilities.

Dell OS9 supports leading SDN technologies and frameworks which can be broken down into three solution categories: **Programmable**, **Overlay** and **Controller**-based.

Choice of Software Defined Networking approach

Open Standards + Open Protocols + Open Source = **Open IT with Choices**



A programmable powerhouse

Dell OS9 packs a powerhouse of advanced programmable features that deliver a simple yet powerful path to an intelligent, automated infrastructure.

OS9 features an industry-standard CLI along with traditional interfaces such as SNMP to ensure that existing skill sets, tools and processes simply work. When ready to move to the next level, Dell's Open Automation Framework™ delivers extensive programmability features that empower enterprises to start building a more agile and resilient infrastructure with Dell's streamlined and simple lifecycle automation tools.

Dell Open Automation framework



OS9's powerful scripting capabilities leverage industry-standard languages and libraries, eliminating the need to learn proprietary languages with immature development environments and toolsets. OS9's extensive capabilities include support for Expect, PERL, Python, Tcl, UNIX and ZSH shell scripts, embedded Puppet and Chef agents¹, RESTful API's, OpenFlow and more.

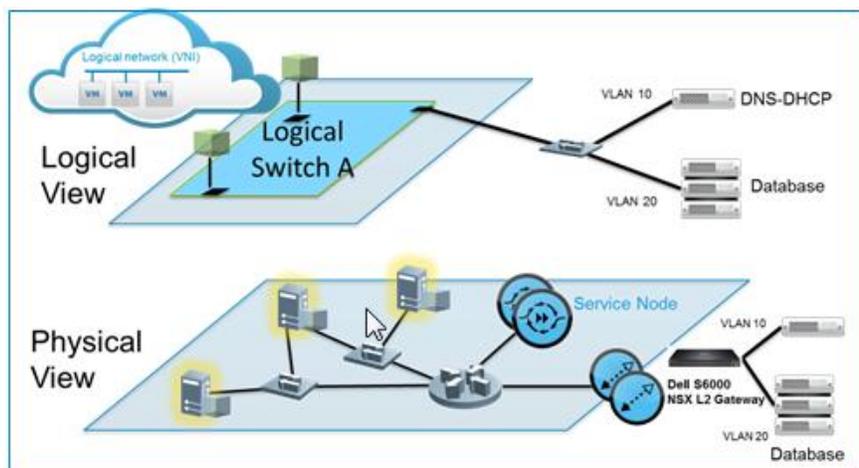
As the SDN and open networking movements continue to produce rapid innovations in networking management and solutions software, the robust programmability features and open interfaces in Dell OS9 combined with our open networking initiative offers the most adaptable and resilient framework providing the most extensive investment protection available in a networking solution today.

Network virtualization with overlays

Network Virtualization Overlay (NVO) solutions offer one of the most simple and cost-effective paths to delivering the benefits of SDN for virtualized and private cloud solutions.

Private-cloud environments need to support a wide variety of applications with varying needs over one common infrastructure. These environments need the ability to automatically provision this variety of workloads and ensure that the connectivity, performance and policy requirements of each application are delivered dynamically and enforced consistently. NVO's connect server hypervisors directly to other hypervisors via logical tunnels, enabling the creation of multiple virtual networks over one common physical network. This can enable a variety of applications to each have their own virtual network that can be tuned to application-specific demands and be deployed in self-service and dynamically orchestrated environments while keeping application policies intact.

Leading cloud and virtualization suites



including Microsoft®, VMware® and OpenStack are currently integrating NVO technology into their platforms. This deep integration of virtual networks with cloud orchestration and provisioning systems provides a central vehicle to create and package an application along with its network and overall policy requirements in a portable container, ensuring that enterprises retain control over their applications and policies.

Enterprises planning for NVO technology should examine the roadmap of their cloud/virtualization suite provider and to choose a physical network provider that has a complementary strategy. Some leading networking vendors have implemented network virtualization strategies that are directly competitive with Microsoft and VMware's own, creating integration challenges and separating application policies into proprietary silos that lock customer data in and prevent workload portability across industry-standard hardware and hybrid cloud providers.

Dell is a leading strategic partner with Microsoft and VMware, enabling us to jointly develop optimal infrastructure technologies that best complement and optimize each NVO offering. Dell's open strategy for NVO compliments and strengthens the integrated network virtualization frameworks of each of these partners ensuring deep integration and strategic alignment.

Dell Active Fabric Switches are seamlessly supported in Microsoft System Center, deeply integrated into VMware vSphere and NSX solutions, and deliver deep integration and network automation for the OpenStack Neutron framework.

OpenFlow and controller-based solutions

Controller-based SDN architectures such as OpenFlow have emerged as a promising new model for network architecture. Controller-based solutions provide a separation of control and data planes by using a central server to maintain networking protocols and databases and program forwarding information directly into switch forwarding tables.

This can be thought of as similar to a traditional large chassis switch with centralized intelligence modules that work together with line cards to provide a single logical switch. Controller-based solutions enable a similar ability enabling independent Ethernet switches to act as linecards controlled by a centralized server that leverages open protocols to deliver simple, scale-out capabilities based on low-cost, industry-standard forwarding hardware.

While controller-based solutions offer tremendous promise, they are still new and may not be appropriate for all deployment types – however the number of supported use cases and corresponding business benefits are growing every day.

Dell was among the earliest supporters of OpenFlow and provides an available option across our N, S and Z-series switches² where we have made significant innovations beyond basic

² Supported OpenFlow features vary by model, see model data sheets for further details

standards compliance including support for up to 160,000 flows on select hardware. Our open approach to SDN offers support for any standards compliant OpenFlow controller on the market, providing customer choice and investment protection. Dell is a very active participant in the open networking R&D community and has OpenFlow deployments with numerous open source and independent controllers and offer additional service and support for our partner controllers including OpenDaylight, NEC and Big Switch Networks.

Active Fabric Controller



Transform & Modernize IT Operations with a Network Designed for the Cloud

AFC Delivers on-demand virtualized network services for OpenStack with fully automated, whole-lifecycle management of the physical infrastructure

Deliver Customized Policy that Provisions & Scales Seamlessly

Provides real-time workload visibility and dynamically scalable policy - delivering adaptive security to make your Data Center untouchable

Experience Ultimate Efficiency with Elastic, Auto-Adapting Fabric Services

Automated topology discovery & forwarding optimization enables simple, seamless scalability - Programmable QoS & DCB enables convergence & higher-density operations

For OpenStack Private Cloud environments Dell offers the Active Fabric Controller. AFC leverages OpenFlow and advanced SDN features to deliver zero-touch deployment for the fabric such that no operator intervention is required — simply rack, cable, power-on, and the fabric comes to life. AFC also offers network, endpoint and policy abstractions, together with a simple GUI and comprehensive API. This enables OpenStack applications to program the network to meet workload needs, and provides simplified visibility and comprehensive programmatic control of the access fabric.

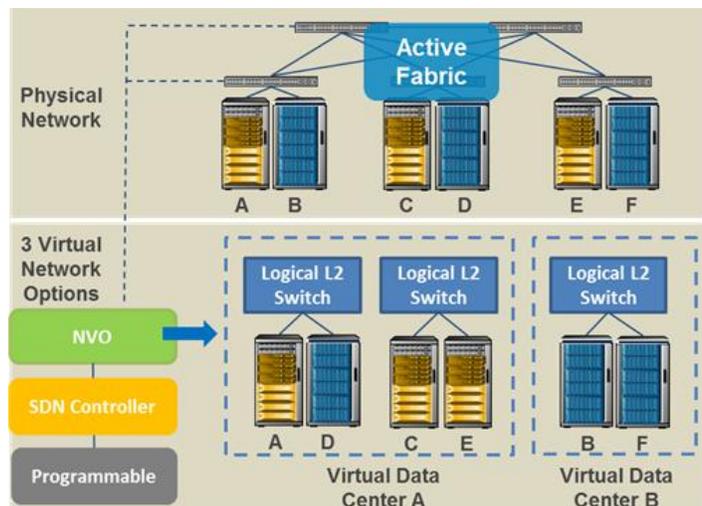
A simple, evolutionary path to SDN

Dell Networking solutions offer a simple, evolutionary path that can evolve legacy architectures and operational models toward a newer lifecycle-based operational model, providing greater business agility while reducing operational overhead.

Rather than forcing rip-and-replace or forklift upgrades, Active Fabric solutions seamlessly integrate into existing networks and can immediately deliver next-generation capabilities when and where they are needed — no forklift required. The modular Active Fabric architecture enables simple, scale-out capabilities, meaning our network solutions can scale seamlessly from tens of hosts to tens of thousands by leveraging the latest leaf-spine and flat network architectures.

To help enterprises get started on their journey to next-generation networking, Dell Active Fabric Manager provides a simple and comprehensive lifecycle management solution that can place enterprises on the fast track to realizing the benefits of SDN. For years, network engineering has been limited by immature and overly complex operational tools and management platforms. Active Fabric Manager brings network administration and engineering into the software age providing a powerful and elegant single-pane of glass solution that empowers network and systems administrators to design, deploy and manage an automated, next-generation network solution without needing to go back to school with every new innovation in underlying network technologies.

AFM's simple interface makes it easy to design a next-generation leaf-spine or flat network architecture optimized for Microsoft, VMware, Citrix and OpenStack environments. AFM maintains network diagrams and provides comprehensive cable plant diagrams to make cabling and installation simple. Next, AFM provides complete device configurations and can deploy the entire fabric from bare-metal with the touch of a button. Once deployed AFM provides robust and automated configuration and operating system management and leverages the robust programmable interfaces in Active Fabric switches to deliver advanced fabric-level data analytics, monitoring and troubleshooting capabilities.



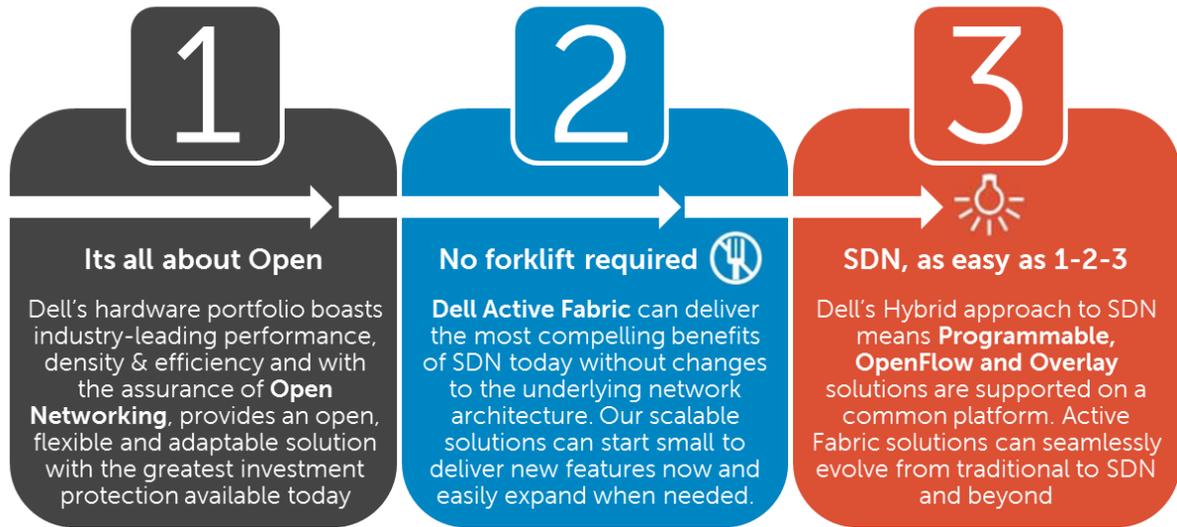
AFM delivers a complete lifecycle-based solution for with a simple, evolutionary model empowering enterprises to realize the benefits of SDN as simply and effectively as possible.

Active Fabric Manager makes scaling easy; it can start with small deployments and grow the fabric as needed, at the pace of the customer. The traditional CLI provides a comfortable environment, and the powerful programmability features paired with AFM's simple tools can empower network and systems administrators to start automating operations, streamlining processes and even automate the design and configuration for OpenFlow and NVO networks.

Dell's SDN and Open Networking³ solutions deliver the industry's most comprehensive breadth of next-generation networking solutions providing a dynamic and adaptable framework with unprecedented investment protection. Active Fabric delivers a simple and powerful model that can empower enterprises to advance at their own pace, leveraging the power of software to deliver a new operational model that evolves with the pace of business.

³ Open Networking is available only on select platforms, visit Dell.com/Networking for more details

Dell's simple approach to SDN: as easy as 1-2-3



[Learn More at Dell.com/Networking](http://Dell.com/Networking)

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ⁱ Requires Dell Networking OS 9.