Open Networking:
Dell's Point of View on SDN

A Dell White Paper

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August 2015

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Abstract

The networking industry today looks much like the mainframe computing market of 40 years ago, with a small number of industry players producing vertically-integrated solutions where both software and hardware are single-sourced. This practice has led to a proprietary industry culture in which innovations are stifled and operations are fragile, complex and expensive.

Meanwhile, data centers, campuses and carrier environments have highly dynamic computing and storage needs. These needs are driving current trends prevalent in the industry: mobility, cloud services and big data. The static nature of the traditional network is not designed to address the computing and enterprise needs of businesses today.

With the evolution of technological milestones like server virtualization and BYOD/mobility, customers now tend to demand agility, automation, open networks and better total cost of ownership (TCO). Meeting customer needs within the traditional networking approach is becoming all but impossible. IT departments, faced with the problem of flat or reduced budgets, are trying to squeeze the most out of their network using device management tools and manual processes. These practices leave little ground for automation within the traditional networking approach. Conventional networking solutions are plagued with issues of inconsistent policies, inability to scale, acute vendor dependency, complexity and operational inefficiencies.

New paradigms are emerging, however, to address the current and changing needs of business. This paper outlines the Dell point of view on software defined networking (SDN) and open networking, offering an overview of the operational benefits of these powerful emerging paradigms and guidance on how to prepare an optimal technology strategy for different use cases. Before diving into SDN, this paper will first explore software-defined data center (SDDC), the larger umbrella which encompasses SDN.

Software-defined data centers

A software-defined data center (SDDC) is an IT facility where the elements of the infrastructure – server, storage and networking – are virtualized and delivered as a service. This approach allows the customers to control the data center via software, allowing the hardware associated with any data center to be maintained through intelligent and efficient software systems. The provisioning and operation of the entire infrastructure can thus be automated by software, allowing a high degree of agility and flexibility. SDDC brings together the infrastructure components (server, storage and networking), moving them from independent siloes into a single controllable environment. The automation achieved by SDDC – and the resulting increase in agility, control, efficiency and reliability – is one of the most important requirements for businesses today.

The core components of an SDDC are: **software-defined computing, software-defined storage and software-defined networking.**

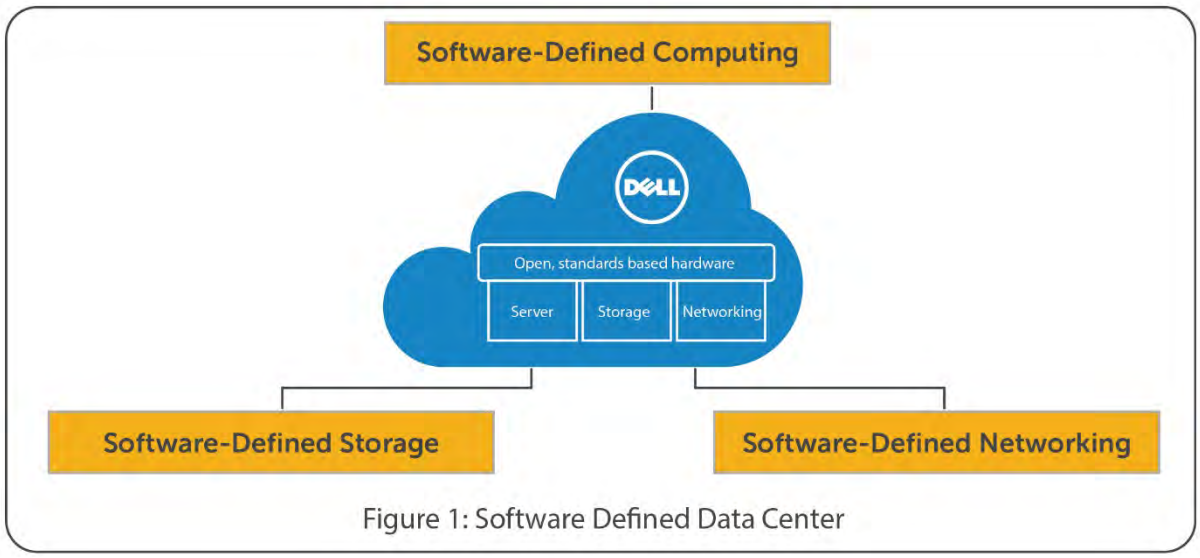


Figure 1: Software Defined Data Center

Software-defined computing

Software-defined computing (SDC) is the server virtualization part of SDDC. Virtualization enables higher server utilization and therefore reduces CapEx, space, power and cooling. It also helps achieve operational efficiency by creating and moving virtual servers in order to drive down operational expenses. In addition to server virtualization, container technologies are an emerging trend. These technologies offer benefits including simple deployment, rapid availability and the ability to leverage microservices. Dell is a strong supporter of both server virtualization and container technologies.

Software-defined storage

Software-defined storage (SDS) is an approach to data storage in which the programming that controls storage-related tasks is decoupled from the physical storage hardware. With SDS, customers can create virtual storage by pooling direct-attached storage (DAS) to a cluster of storages. This implementation method allows pooled storage resources of an SDS environment infrastructure to be

automated, efficiently allocating resources to match the dynamic needs of the application and business. SDS offers flexibility and automated management of the storage resources along with cost efficiency.

Software-defined networking

The legacy of closed networking has prevented the emergence of a robust independent software industry able to solve business challenges in open x86 ecosystems. The proprietary nature of the networking ecosystem stifles the tremendous innovation potential that arises from open ecosystems and value chains. Software-defined networking (SDN) presents an innovative approach to solving key enterprise challenges.

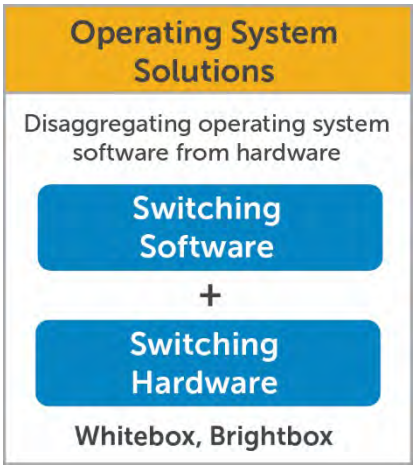
With the advent of SDN, the networking technologies are now freed from proprietary strangleholds. This sudden freedom has resulted in a burst of rapid innovation as entrepreneurship and the principles of capitalism break through the closed and proprietary legacy of the networking industry, creating a wave of new economic benefits, innovation and opportunities.

SDN offers a centralized, programmable network that can dynamically provision in order to meet business' changing needs. Using a pay-as-you-grow model, SDN offers reduced capital expenditure for a "greenfield" deployment. Additionally, SDN offers other merits like reduced operational expenses, improved agility and flexibility.

The Dell approach to SDN

Dell works to achieve SDN via disaggregation. This approach, offering customers flexibility, choice and innovation, can be accomplished in three ways: **disaggregation of operating system and hardware; disaggregation of virtual networking and physical networking;** and **disaggregation of the control plane and data plane**.

Disaggregating the operating system and hardware



Dell was the first global technology provider to offer customers their choice of network operating systems and technology architectures to best meet the unique needs of their businesses. In order to take full advantage of the benefits that open networking and SDN can offer, IT administrators must look at the networking industry differently, 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 freedom to select a preferred hardware vendor and preferred OS vendor and to choose from a vast array of independent software solutions to best meets the strategic needs of their business. By offering a choice of supported operating systems on select models of industry-leading hardware portfolio, Dell has enabled networking consumers to take advantage of this powerful model.

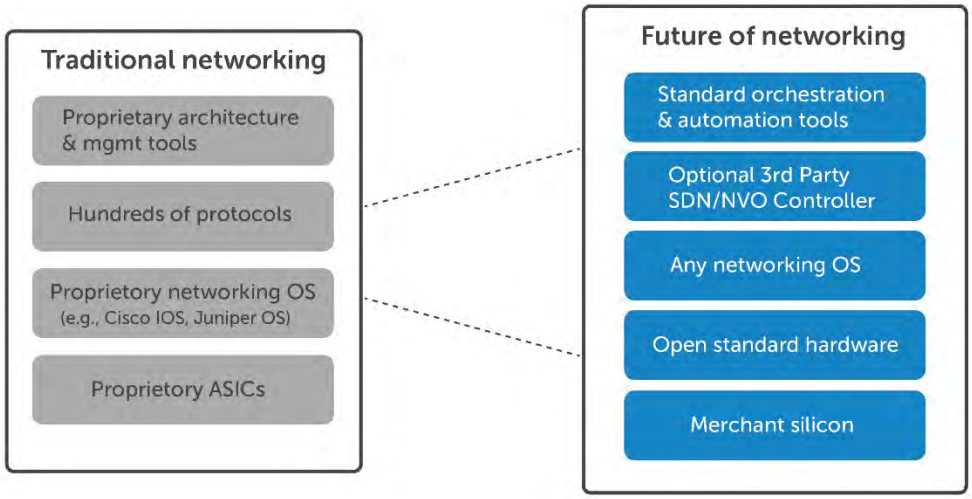


Figure 2: Dell fueling open networking revolution

Disaggregation is an evolutionary approach for implementing SDN in an enterprise's IT infrastructure. The foundation of this approach for achieving SDN 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 industry-standard chipsets and components– a model that the largest networking vendors have only 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 networking solutions, combined with open networking partners' advanced offerings, deliver the broadest range of next-generation network and SDN frameworks. This range ensures investment protection, direct access to open networking innovations and true freedom from vendor lock-in.

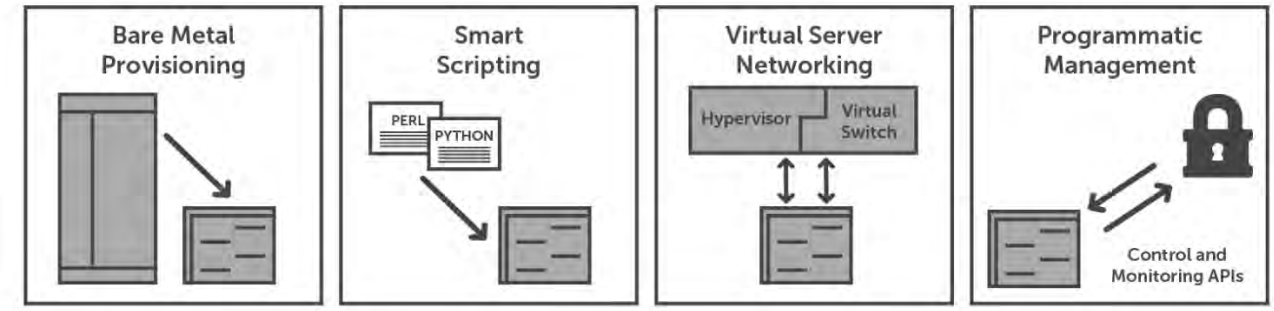
Dell open networking solutions are aligned with the open compute project and provide the open networking install environment (ONIE), enabling customers to choose between supported operating systems including the Dell Networking Operating System (OS9), Cumulus Linux, Big Switch and IP Infusion OcNOS™.

USE CASE: A customer wants to migrate towards an agile, feature-rich, flexible network to achieve scalability, automation and openness using a traditional CLI.

Dell Networking OS9 powers the Dell Networking product portfolio. Hardened in some of the largest and most demanding environments in the world to meet reliability, scalability and serviceability requirements, Dell OS9 is a powerhouse of advanced programmable features that deliver a simple yet powerful path to an intelligent, automated infrastructure.

Dell's Open Automation framework leads the industry in providing an open standard-based automation for the network operations. The portfolio offering allows data centers to simplify operations while improving efficiency and deployment turnaround times. The Open Automation Framework provides faster installation and configuration of networks, ease of management, improved monitoring capabilities, improved network error correction turnaround times and reduced operational expenses.

The Open Automation Framework is comprised of a suite of inter-related network management tools that can be used together or independently.

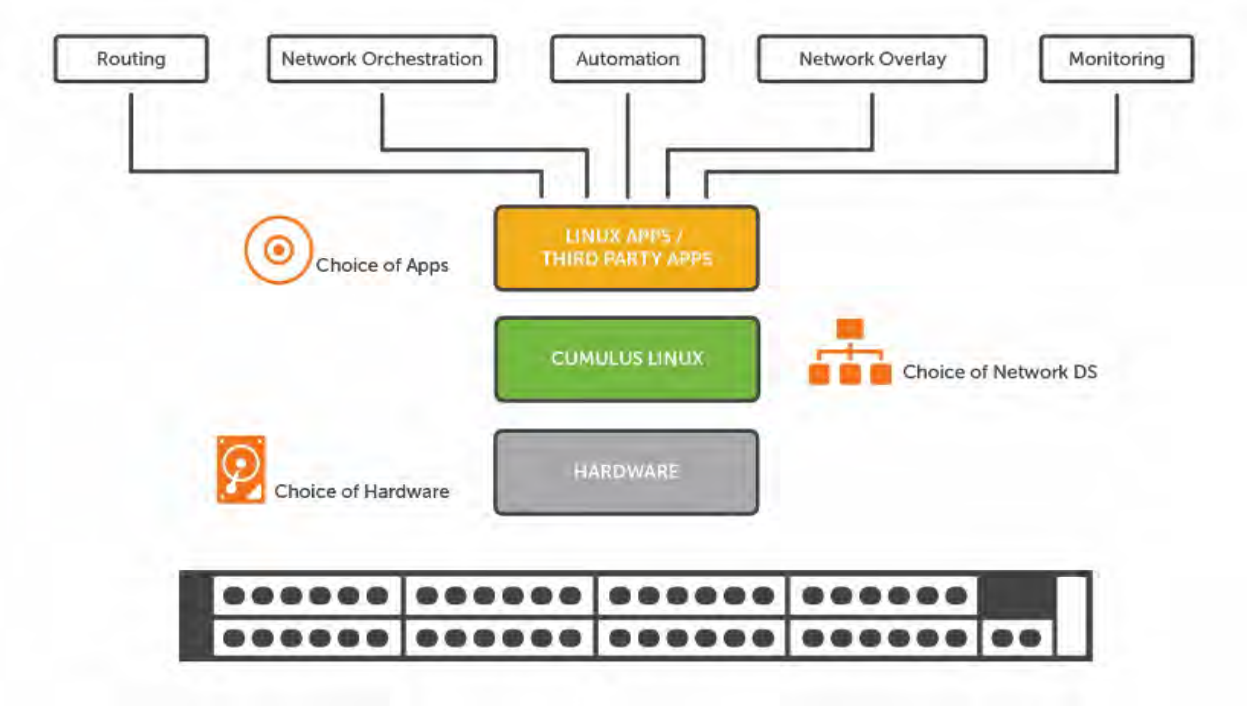


- **Bare Metal Provisioning** (BMP) provides reduced installation time, automatic network switch configuration and automated configuration updates to eliminate configuration errors, enforce standard configurations, reduce operational expenses and simplify operating system upgrades.
- **Smart Scripting** improves network availability and manageability by allowing network administrators to deploy custom monitoring and management scripts on Dell switches. These switches support industry-standard languages such as Perl and Python, eliminating the need for IT administrators learn a new proprietary language.
- **Virtual Server Networking** requires infrastructures to be dynamic to ensure that network connectivity, QoS, and security policies are maintained when VMs are migrated. Virtual Server Networking increases flexibility by automatically provisioning VLANs when VMs are migrated and offer support for multiple hypervisors such as VMware and Citrix XenServer.
- **Programmatic Management** simplifies network management by integrating with multiple third party management tools. This allows seamless integration with programmatic interfaces and system management tools. Programmatic management greatly improves network manageability by allowing Dell switches to be managed by third-party system management tools via standard programmatic interfaces.

USE CASE: A customer has an IT infrastructure and staff which is predominantly Linux based and wants to migrate towards an agile and flexible network to achieve scalability, automation and openness using their existing tools and expertise.

Cumulus Linux is a full-featured networking operating system that enables customers to build a modern, scalable, and cost-effective data center. A software distribution that runs on top of industry standard networking hardware, Cumulus Linux is a software-only solution that provides the ultimate flexibility for modern datacenter network designs and operations, enabling a best-of-breed hardware ecosystem and a best–of-breed solutions ecosystem with a standard operating system (Linux). This solution is the first full-featured Linux OS for data center networking running seamlessly over bare metal switches and enables a large ecosystem of native Linux applications and automation tools on standard networking gear.

Cumulus Linux delivers new levels of innovation and flexibility to the data center. Combined with Dell's open-networking switches, this disaggregated solution offers enhanced manageability, clustering, monitoring, and orchestration – many of the same benefits found in virtualized-server environments.



USE CASE: A customer is looking for an economical, scalable and secure method of separating network users and resources across a common infrastructure using MPLS network virtualization.

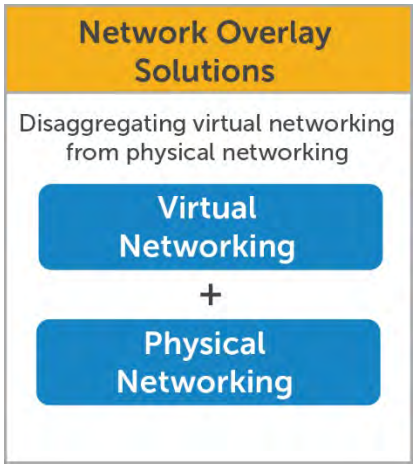
IP Infusion is a leading provider of intelligent network software for telecom and data communications services. The company recently announced **OcNOS™**, the first, full-featured network operating system for data center and enterprise networking. OcNOS includes advanced capabilities such as extensive protocol support for multiprotocol label switching (MPLS) and brings the power of the Open Compute Project, an open hardware movement and foundation, to data networking to reduce operational complexity. OcNOS is a robust, programmable and innovative operating system featuring a single software image that runs across the entire portfolio of leading network device vendors utilizing the Open Compute platform.

USE CASE: A customer wants to migrate towards a simple, scalable, agile, cost-effective data center network monitoring fabric.

Big Tap™ Monitoring Fabric is an innovative network monitoring solution that allows users to tap traffic anywhere in the network and deliver it to troubleshooting, network monitoring, application-performance monitoring or security tools. Big Tap offers a practical, cost-effective entry point for SDN and provides optimal visibility and scalability. At the core of the Big Tap Monitoring Fabric is the Big Tap Controller.

Big Switch's Big Cloud Fabric™ (BCF) is the industry's first data center fabric built using open Ethernet switches and SDN controller technology. Customers benefit from unprecedented application agility due to automation, massive operational simplification due to SDN, and dramatic cost reduction due to HW/SW disaggregation. Embracing hyperscale data center design principles, the Big Cloud Fabric solution enables rapid innovation and ease of provisioning and management while reducing overall costs, making it ideal for current and next generation data centers.

Disaggregating Virtual Networking and Physical Networking



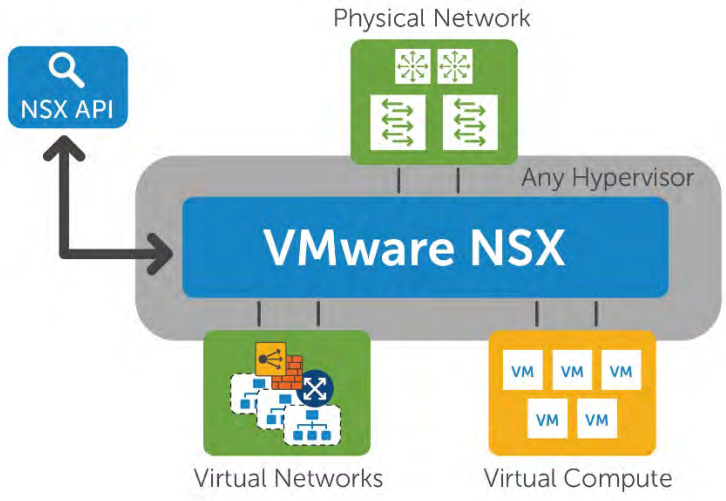
Network virtual overlay solutions (NVOs) offer a simple, cost-effective path to delivering the benefits of SDN for virtualized and private cloud solutions to support a wide variety of applications with varying needs over a common infrastructure. These environments need the ability to automatically provision a variety of workloads, ensuring that connectivity, performance and policy requirements are delivered dynamically. NVOs connect server hypervisors directly to other hypervisors via logical tunnels, enabling the creation of multiple virtual networks over one common physical network. This solution enables each of a variety of applications to 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. Technologies like VXLAN and NVGRE are used for tackling issues with virtual networking.

Leading cloud and virtualization suites, including Microsoft, VMware and OpenStack, are currently integrating the network overlay 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 overlay policy requirements in a portable container. This integration ensures that enterprises retain control over their applications and policies. Dell is a leading strategic partner with Microsoft and VMware, working to jointly develop optimal infrastructure technologies that best complement and optimize each network overlay solution offering.

USE CASE: A customer has an IT infrastructure that is that is already VMware intensive and wants to achieve simplified network design and operations along with elements like agility and improved security by micro-segmentation.

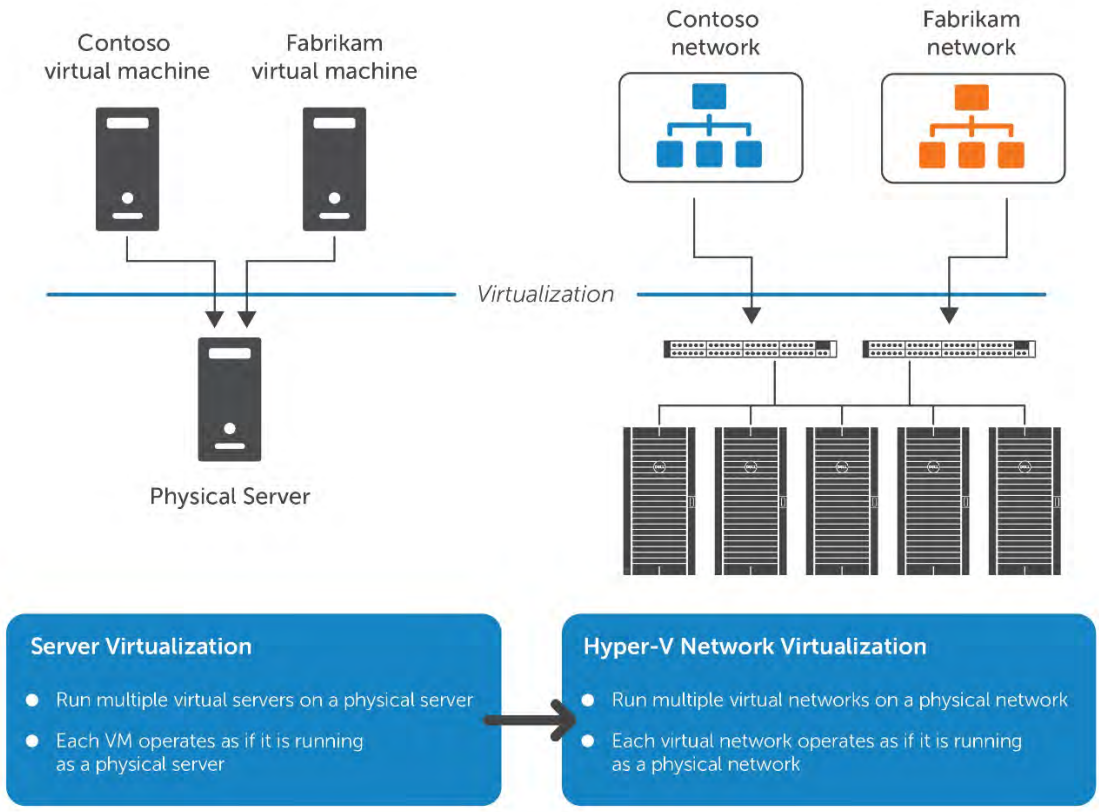
In this case, **VMware NSX** delivers the operational model of a virtual machine for the network. Virtual networks are programmatically provisioned and managed independent of underlying hardware. VMware NSX provides a complete suite of simplified logical networking elements and services, including logical switches, routers, firewalls, load balancers, VPN, QoS, monitoring and security. These services are provisioned in virtual networks through any cloud management platform leveraging the NSX APIs and can be arranged in any topology with isolation and multi-tenancy. The control plane is managed centrally through the NSX controller. The NSX data plane consists of NSX vSphere distributed switches (VDS) with add-on components such as distributed routing, distributed firewalls, and VXLAN

bridging support. The NSX vSwitch abstracts the physical network and provides access-level switching in the hypervisor. Overlay networking enables extension of a layer 2 (L2) segment anywhere in the fabric without physical network design constraints. Virtual networks are deployed non-disruptively over any existing network and on any hypervisor. With NSX, the networking provisioning time is reduced from days to seconds. Operational efficiencies are gained through automation, integration with a third-party network and non-disruptive deployment over existing physical networks.



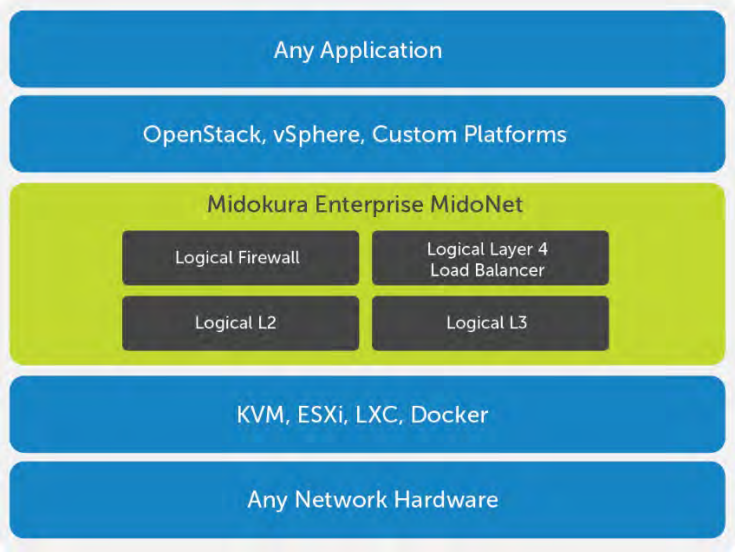
USE CASE: A customer has an IT infrastructure that is already Hyper-V intensive and wants to achieve simplified network design and operations along with elements like agility, flexibility and automation.

Microsoft Hyper-V network virtualization (HNV) provides a virtual network abstraction on top of a physical network. This abstraction provides virtual networks to virtual machines which operate the same way as a physical network. This is similar to the abstraction that hypervisors provide to the operating system running in virtual machines. HNV provides this abstraction through an overlay network on top of the physical network for each VM network. Network virtualization decouples virtual networks from the physical network infrastructure and removes the constraints of VLAN and hierarchical IP address assignment from virtual machine provisioning. This flexibility makes it easy for customers to move to (infrastructure-as-a-service) IaaS clouds, and makes it efficient for hosts and datacenter administrators to manage infrastructure. This solution also maintains multi-tenant isolation and security requirements. HNV supports NVGRE as a mechanism to virtualize the IP address.



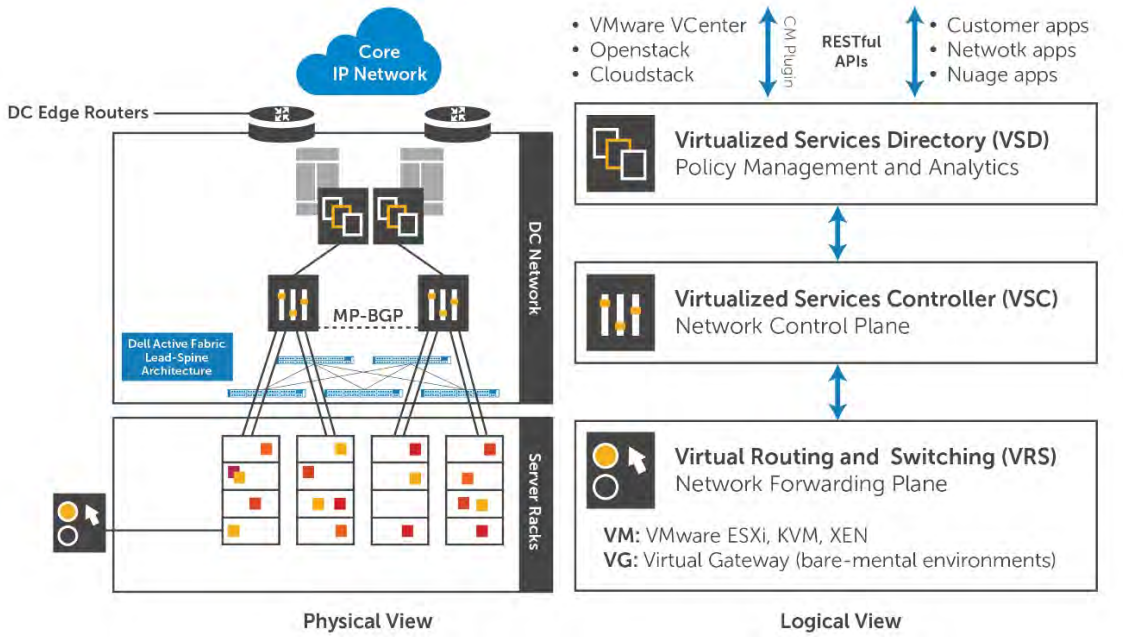
USE CASE: A customer wants to achieve improved application deployment time, network scalability and agility but wants a solution that works with any underlying hardware and is hypervisor agnostic in order to protect investment and vendor lock-in.

Midokura Enterprise MidoNet is a software-based, highly scalable and resilient network virtualization system for OpenStack and Neutron-compatible environments. MidoNet is an open source network virtualization platform for IaaS clouds. With its distributed architecture, MidoNet enables enterprises and service providers to build, run and manage virtual networks with increased control, security and flexibility. Using industry standards and existing physical infrastructures, MidoNet reduces costs and improves the stability, scalability and performance of networks.



USE CASE: A customer wants to achieve improved application deployment time, network scalability and agility but wants a solution that works with any hypervisor and data center network fabrics in order to avoid vendor lock-in.

Nuage Networks Virtualized Service Platform (VSP) is an SDN solution that virtualizes any data center infrastructure and automatically establishes connectivity between compute resources. The automated instantiation of network services makes the data center dynamic and consumable. VSP leverages the programmable business logic and a powerful policy engine to provide an open solution that scales as per the needs of multi-tenant data centers. The key components of a VSP solution include a Virtualized Services Controller (VSC), Virtualized Services Directory (VSD) and Virtual Routing and Switching (VRS).

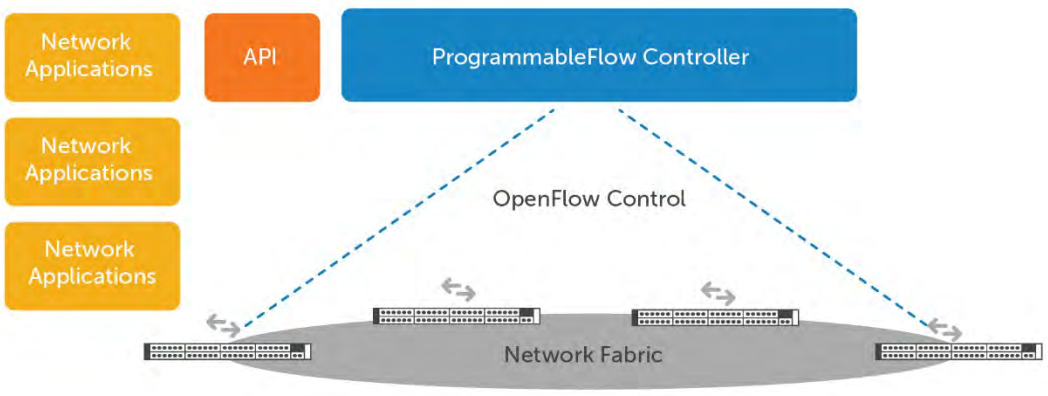


Disaggregating the control plane and data plane

Control plane solutions provide a separation of control and data planes by using a central control server to maintain networking protocols and databases and to program forwarding information directly into switch forwarding tables. This can be thought of as similar to a traditional large chassis switch with centralized control modules that work together with line cards to provide a single logical switch. Controller-based solutions enable independent Ethernet switches to act as linecards controlled by a centralized control server that leverages open protocols to deliver simple, scale-out capabilities based on low-cost, industry-standard forwarding hardware.

USE CASE: A customer is looking for a general purpose commercial SDN controller.

Introduced in 2011 and installed in production networks around the world, **NEC Programmable Flow® Networking** Suite was the first commercially available software-defined network (SDN) solution to leverage the OpenFlow protocol, enabling full network virtualization and allowing enterprises, data centers, and service providers to easily deploy, control, monitor and manage secure multi-tenant network infrastructures. Programmable Flow SDN automates and simplifies network administration for greater business agility and provides a network-wide programmable interface for unifying the deployment and management of network services with the rest of IT infrastructure. This solution is simple, fast, open and secure to meet the changing needs of today's businesses.

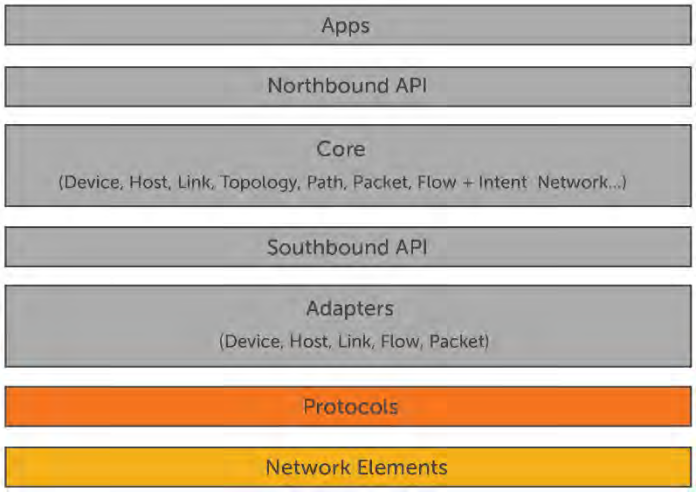


USE CASE: A customer is looking for an open source general purpose SDN controller.

OpenDaylight is an open source project with a modular, pluggable, and flexible controller platform at its core. This controller is implemented strictly in software and is contained within its own Java Virtual Machine (JVM). As such, it can be deployed on any hardware and operating system platform that supports Java. OpenDaylight can be a core component within any SDN architecture. Building on an open source SDN and network function virtualization (NFV) controller, OpenDaylight enables users to reduce operational complexity and extend the life of their existing infrastructure hardware while enabling new services and capabilities only available with SDN. The controller exposes open northbound APIs which are used by applications. These applications use the controller to gather network intelligence, run algorithms to perform analytics and then use the controller to orchestrate the new rules throughout the network.

USE CASE: A customer is looking for a service provider oriented open source SDN controller.

The **Open Networking Operating System (ONOS)** is the first open source network operating system targeted specifically for service provider and mission critical networks. ONOS is built to provide high availability (HA), scalable networks with high performance demands. The features defining ONOS are distributed core, software modularity, southbound APIs and northbound APIs. ONOS brings carrier-grade features like scale, availability and performance to the SDN control plane, enabling web style agility, helping service providers migrate their existing networks to white boxes and reducing CapEx and OpEx.



The various SDN solutions provided by Dell and its partners can be used in the telecommunication space to provide an open solution to accelerate deployments of the technology. Dell's NFV platform is designed to bring many of these elements together in a simpler, more streamlined and more open offering that leverages technology from both Dell and third-party vendors. The platform is highly scalable for use in a wide range of carrier environments, and includes software and open interfaces for management and orchestration (MANO) and simple integration.

Summary

Dell's vision for SDN is defined by open networking. The Dell approach is to simplify networking through 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. Together with its ecosystem of partners, Dell aims to achieve a more open, flexible and innovative solution which will increase choice and capability and offer a compelling value proposition to customers.