

# Network Transformation with Software-Defined Networking and Ethernet Fabrics

The Brocade One™ strategy represents a smooth transition to a world where information and applications reside anywhere. Brocade cloud-optimized network solutions, enabled by Brocade® VCS® Ethernet Fabrics and Software-Defined Networking (SDN), deliver on the promise of Brocade One. Exponential traffic growth and server virtualization are causing classic network architectures to constrain the application and service innovation needed to support network users. Software-Defined Networking with Ethernet fabrics are emerging technologies that are rapidly being adopted by innovative network operators. These technologies help transform the network and unlock its intelligence to provide the new services and powerful analytics that are needed to deliver the applications and services demanded by today's businesses and consumers. Unlike competitive approaches, Brocade offers a carrier-grade cloud network that enables Software-Defined Networking without sacrificing performance, scalability, or reliability.

## Classic Network Architectures Are a Constraint

Demand for services and network usage is growing at a brisk pace. Growth drivers like video traffic, big data, and rapidly increasing mobile usage provide increased opportunities for revenue. At the same time, these drivers are also adding more risk and significant challenges for network operators everywhere.

Challenges are manifest for all types of network operators:

- Mobile operators are dealing with spectrum congestion, the transition to IP, and millions of mobile users.
- Telco operators are facing huge growth in global IP traffic, coupled with unchanging end-user monthly billing.
- Data center operators are dealing with large growth rates in server and virtual machine counts.
   Further, increasing machine-to-machine communication has resulted in an amount of east-west traffic that is ten times that of north-south traffic in a data center.
- Research networks are facing a need to handle, store, and transport massive amounts of data.

Different types of network operators face different primary challenges, but all of them face the same major constraint: the network.

In order to address the above challenges, operators need to increase the efficiency, flexibility, agility, and application and service scalability of their current network. Classic network architectures have several problem areas that network operators need to solve to handle today's challenges. Removing redundant layers and links in the network allows network operators to drive more efficiency into network traffic flows. Making the network more agile enables network changes to be done more quickly and efficiently, as well. Further, operators can drive more flexibility and modularity into network infrastructure by providing a programmatic Application Programming Interface (API) for protocols running outside the device to program the data plane of a network element.

The common thread behind today's challenges for all network operators is the architecture of the network itself. The network is holding back network operators of all types. Classic network architectures are very

specialized, from applications to operating systems to hardware. In addition, these architectures have been designed with multiple tiers to support north-south traffic and with various oversubscription models based on typical, fairly static, traffic patterns. As the prominence of east-west traffic rises in tandem with virtualization, and collaboration between end users and devices in the network increases, the classic network, due to its inflexibility and specialization, is not able to adapt. The network as currently constituted is brittle, localized, slow, and has not evolved to support the kinds of operations users demand today.

# Taking the Network into the Future

When the network itself is the constraint, a new network paradigm is needed. To solve today's challenges, the new network needs flexibility, intelligence, and distributed control—in short, it needs virtualization. By embracing a cloud- optimized, scalable, adaptive network, network operators can overcome the constraints they face.

"Software is eating the world."

-Marc Andreesen

The power of software is evident across much of the technology landscape, and it is being extended to the network. The new network combines the power of fabric-based architectures with SDN—a powerful new approach drawing support from the most demanding network operators in the world. SDN enables organizations to control their networks programmatically, helping them to add capabilities and scale without compromising performance, reliability, or user experience.

The transformation of the network from the classic architecture of discrete physical tiers to a highly resilient, cloud-optimized architecture is already under way, and the evolution continues to move forward.

# The Beginning of the Transformation: Ethernet Fabrics

Brocade began addressing the limits of the classic network architecture with Ethernet fabrics. First delivered in 2010, Brocade VCS technology took the first step toward abstracting the control plane by spreading intelligence across the nodes of the network. Brocade VCS technology is a proven solution built on the Brocade fifteen-year heritage in fabric networks.

## **Ethernet Fabrics**

Compared to classic hierarchical Ethernet architectures, Ethernet fabrics provide higher levels of performance, utilization, availability, and simplicity. At a minimum, Ethernet fabrics have the following characteristics:

Flatter Ethernet fabrics eliminate the need for Spanning Tree Protocol, yet are still completely interoperable with existing Ethernet networks.

Flexible Ethernet fabrics can be architected in any topology to best meet the needs of any type of workload.

Resilient Multiple "least cost" paths are available for high performance and resiliency.

Elastic Ethernet fabrics easily scale up and down at need.

More advanced Ethernet fabrics borrow further from Fibre Channel fabric constructs:

- Ethernet fabrics are self-forming and function as a single logical entity, in which all switches automatically know about each other and all connected physical and logical devices. Management can then be domain-based rather than device-based and defined by policy rather than repetitive procedures.
- These features, along with virtualization-specific enhancements, make it easier to explicitly address
  the challenges of Virtual Machine (VM) automation within the network, thereby facilitating better IT
  automation.
- Protocol convergence (for example, Fibre Channel over Ethernet [FCoE]) may also be a feature, intended as a means of better bridging Local-Area Network (LAN) and Storage-Area Network (SAN) traffic.

Brocade VCS Ethernet Fabric technology delivers a highly automated, dynamic, and resilient foundation for the network fabric layer, providing always-on active-active connectivity, and making it an ideal foundation for a Software-Defined Network. With their multipath architecture and full link utilization, Ethernet fabrics are well suited for east-west traffic, making them optimized for virtualization and the cloud. Brocade Ethernet Fabrics are flat and fast, with low latency. By distributing intelligence across the entirety of the network, each network switch has a holistic view of the fabric. This provides the greatest resiliency from a self-forming and self-healing architecture, with fast network reconvergence, real-time scaling, and zero-touch VM. Brocade brings additional value to the fabric architecture by making the entire fabric operable as a single logical switch, which minimizes operational overhead for network operations and improves controller scalability and efficiency.

# Continuing the Transformation: Software-Defined Networking

SDN continues the network evolution by providing a software abstraction layer on top of the physical network infrastructure, enabling control plane functions distinct from the data plane and from the discrete physical network device's internal control plane. By enabling one overarching orchestration level, SDN directly addresses the inflexibility and complexity that makes today's networks a constraint for network operators. With SDN, networks see many benefits, becoming more programmatic, faster at adapting to business needs, and more efficient in reducing costs and power consumption.

The value of SDN resides in its powerful abstractions. By hiding physical infrastructure complexity and providing transport layer visibility for applications and services, SDN helps make behavior more provable and network management simpler. SDN brings virtualization to the network, centralizing network operation and management and facilitating rapid application development through increased network intelligence and an open environment. This means that network operators are able to offer and scale an increased number of network applications to support new services. New monetization streams are possible through flexible business models, and capacity constraints can be cost-effectively resolved through optimized flow control.

# **SDN Components**

SDN is an overarching framework that encompasses protocols and technologies like OpenFlow and OpenStack and affects all planes of the network. It is driven by the Open Networking Foundation (ONF), which has enlisted more than 60 major companies as its members.

Figure 1 shows a reference model from ONF, illustrating a complete view of a Software-Defined Network. There are options for network operators within each component, but all are necessary to consider when deploying a Software-Defined Network.

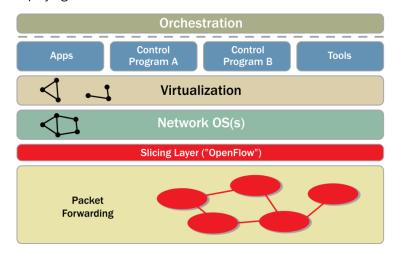


Figure 1. ONF Reference Model.

There are three primary areas of focus in an SDN solution:

- The network virtualization layer ("data plane"): This layer is where tunnel overlays are used as the
  means of transport for traffic that is removed from physical network constraints and controlled by the
  cloud management layer.
- The value-added services layer ("control plane"): This layer provides programmatic control APIs as the slicing layer that gives control of specific traffic flows to network operators. OpenFlow is an important standardized protocol for Layer 2/3 forwarding, while Brocade OpenScript™ is a standards-based API for Layer 4/7 forwarding control. The services layer needs open standards to foster a rich ecosystem of network application development and broad interoperability with different controllers.
- The cloud management layer ("management plane"): This is the orchestration layer, where network operators control the policies of their network through standards-based interfaces and plugins to orchestration frameworks, such as OpenStack, CloudStack, and vCenter.

The abstraction layer provided by SDN does not relegate the physical network infrastructure as inconsequential. The packet forwarding layer affects overall performance and the ability to deliver services across the network. To best enable SDN, high-performance forwarding, simplified deployment and operations, and support for rich real-time analytics need to be enabled with programmatic control up to higher layer management and orchestration.

# Use Cases: SDN Solves Problems for Networks of All Types

SDN is more than theory; it will play an important role in continuing the transformation for networks of all types. Several early use cases have emerged that solve real problems that are difficult—if not practically impossible—to solve in traditional networking.

### **Hyper-Scale Data Centers with Tunnels**

For network operators managing hyper-scale data centers, SDN solves the problem of scaling to and managing hundreds of thousands of highly virtualized physical servers. The scale of these data centers creates extremely difficult management and operational challenges, with the need to handle millions of VMs and their mobility. For example, Layer 2 domains are limited to 4,000 VLANs, and Layer 2 traffic is constrained to VLAN boundaries. Further, moving a VM makes its application unreachable while the network updates the MAC address table. In hyper-scale data centers, these updates can cause serious disruptions of service. With the scale needed for VLANs and MAC addresses, and the requirement around moving VMs across a Layer 3 domain, classic network architectures simply cannot handle both making changes and maintaining uptime.

Network virtualization, an SDN application, directly addresses this problem. Using tunnels, a network operator can isolate the MAC addresses needed on the server level from the physical infrastructure and manage the operations all through the orchestration layer. In addition, tunneling solves the VLAN limitations for VM mobility by allowing Layer 2 traffic to run over Layer 3 overlays. This significantly increases the ease with which VMs can be deployed and moved in a network operator's environment.

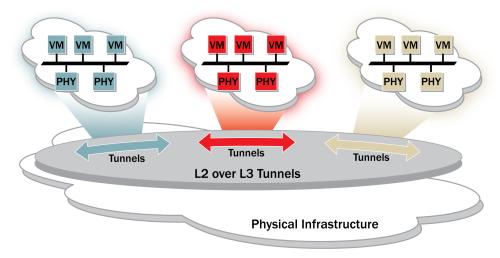


Figure 2. Example of an SDN Solution with Tunnels.

There are multiple applications for the network virtualization use case. For example, a multitenant hosting provider can use SDN to link its physical and virtual servers, its local and remote facilities, and public and private clouds into a single seamless logical network. This creates a scalable situation in which each customer has its own isolated view of the provider network. Another use case example is a cloud data center with SDN. SDN enables the cloud provider to take its single fabric architecture and add a layer of virtualization to it. Doing so allows each of the provider's tenants to see a completely different view of the data center network design based on the tenant's individual requirements.

### Metro and WAN Flow Management with OpenFlow

For network operators dealing with a large amount of video traffic, SDN greatly improves traffic engineering. By using an OpenFlow controller in the network operation center, network operators can create a system that can redirect and distribute traffic based on business policies that are programmed in by the network operator.

OpenFlow allows network operators to automatically handle congestion hot spots and reduce the complexity that video traffic causes for traffic engineering. The application here provides a more granular level of control over network traffic for network operators.

Each of the use cases discussed above presents an example of how SDN addresses real problems with networks that operators are facing today. SDN is applicable across a wide range of networks, and operators of all types can realize its benefits. When SDN is combined with Ethernet fabrics, true network intelligence is achieved.

# The Brocade Position: Bringing Ethernet Fabrics and SDN Together

SDN is the continuation of the network transformation started by Ethernet fabrics. Just as Ethernet fabrics simplify network management and operations on the physical level, SDN does so on the logical level. Ethernet fabrics provide the network fabric layer of a complete SDN solution, emphasizing reliability and simplicity in the foundation of the solution. By combining Ethernet fabrics with SDN, network operators can optimize their network for virtualization on every level and enable the kind of collaboration that is key in networks today.

Brocade is a strong public supporter of SDN and has helped drive movements for enabling technologies that are part of SDN, such as OpenFlow. Brocade endorsed OpenFlow in 2010, participated in its first

public demo of OpenFlow in 2011, and is productizing this revolutionary way of networking today. Brocade has been solving network architecture problems in the data center with Ethernet Fabrics as well, launching the first product in 2010 and seeing significant adoption rates. Fabric architectures will form the foundation for SDN, and Brocade is driving deployable solutions in this space today. SDN, coupled with fabrics, is a crucial part of the transformation of the network from its current position as a constraint to that of a valuable asset.

An SDN solution deployed with Brocade products and technology allows network operators to scale with unprecedented speed and value through Brocade high-density platforms, to deploy services over a cloud-optimized network through Brocade highly differentiated cloud, data center, and routing solutions, and to enable rapid deployment of third-party applications through an open environment, helping network operators simplify operations and deliver new revenue-generating services.

### **OpenFlow-Enabled Products**

To enable SDN deployments, Brocade supports OpenFlow 1.0 on its carrier-grade products, and Brocade is committed to interoperating with any controller that supports the OpenFlow 1.0 standard. Brocade believes that flexibility and interoperability enable the most efficient and valuable SDN deployments for network operators. With this in mind, Brocade enables OpenFlow in its hardware. This means that OpenFlow on Brocade routers and switches runs at line rate for any interface speed, from 1 GbE to 100 GbE.

# Flexibility and Interoperability

OpenFlow is a primary element of SDN today, but providers need to address each component to deploy a complete and fully realized SDN solution. Brocade believes in SDN that is technology-agnostic. When it comes to tunnels, network operators should be able to choose for themselves which tunnel technology works best for the particulars of their network; thus, Brocade SDN solutions embrace all types of tunnels. In the same vein, Brocade believes in open APIs. Open APIs give network operators a more complete view into the means by which the orchestration layer interacts with the network, enabling operators to further customize and increase the effectiveness of their deployment.

By actively ensuring that Brocade products are interoperable with and supportive of a wide range of tunnel technologies, open programmatic APIs, and OpenFlow controllers, Brocade helps network operators transform the network and transcend the limitations and constraints that hold them back today. With the "better together" nature of Brocade Ethernet Fabrics and SDN, Brocade takes the extra step to not only continue addressing existing problems, but to provide new and increased value in the future.

To learn more about SDN with Brocade, please read "Exploring SDN with Brocade" on Brocade.com.

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