The 2013 Guide to Network Virtualization and SDN

Part 3: The Network Virtualization and SDN Ecosystem

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Executive Summary

Over the last year, the hottest topics in networking have been Network Virtualization (NV) and Software Defined Networking (SDN). There is, however, considerable confusion amongst enterprise IT organizations relative to these topics. There are many sources of that confusion, including the sheer number of vendors who have solutions that solve different problems using different solution architectures and technologies, all of whom claim to be offering SDN and/or NV solutions.

The primary goal of the ***2013 Guide to Software Defined Networking & Network Virtualization*** (The Guide) is to eliminate that confusion and accelerate the adoption of NV and/or SDN. The guide will achieve that goal by walking the readers through the following set of topics:

1. What are the problems and opportunities that NV and SDN help to address?
2. What are the primary characteristics of NV and SDN solutions?
3. How does NV and SDN help IT organizations respond to problems and opportunities?
4. How are IT organizations approaching the evaluation and deployment of NV and/or SDN?
5. What is the role of organizations such as the ONF and the OpenDayLight consortium?
6. What approach are the key vendors taking relative to NV and SDN?
7. What should IT organizations do to get ready for NV and SDN?

The Guide will be published both in its entirety and in a serial fashion. This is the third of the serial publications. The first publication focused on NV and the second publication focused on SDN[1]. This publication will focus on the NV and SDN ecosystem and will provide a general overview of that ecosystem as well as a detailed analysis of one of the key members of the ecosystem – Nuage Networks. The fourth and final publication will focus on planning for NV and SDN.

1 webtorials.com/Metzler

Overview of the NV and SDN Ecosystem

One measure of the extent of the NV and SDN ecosystem is that there are currently more than 100 members of the Open Networking Foundation[2] (ONF). This subsection of The Guide identifies the major categories of organizations that are part of the NV and SDN ecosystem and briefly discusses the value proposition of each of the categories.

This subsection of The Guide also identifies representative members of each category of organizations that are part of the NV and SDN ecosystem. The representative members that are identified either currently provide the indicated functionality or can be expected to provide the indicated functionality in the near term. As is explained below, in some instances there can be a very wide range in terms of the functionality provided by the members of a given category.

Merchant Silicon/Chip Vendors

Value Proposition: These vendors are in a position to provide hardware support in switching chips for protocols such as OpenFlow and VXLAN. This will have the effect of increasing the speed and scalability of solutions. Longer term there is also the possibility of at least some of these vendors developing cost-effective switch silicon that is optimized for OpenFlow and other controller/switch protocols.

Representative Members:

- Broadcom
- Intel
- Marvell
- Mellanox

HyperScale Data Centers

Value Proposition: Part of their value proposition is that these high-profile vendors either already are or are likely to be early adopters of SDN. As a result, these vendors are having a significant indirect impact on the development of SDN. In addition, vendors such as Google, Yahoo and Facebook are board members of the ONF. As such, these vendors directly influence the work of the ONF in general and of the evolution of the OpenFlow protocol and the northbound API in particular.

It is possible that some of these vendors will also influence the development of NV. However, some of the major players in this segment of vendors, such as Facebook and Google, currently make little use of NV.

Representative Members:

- Yahoo
- Google
- Facebook

[2] https://www.opennetworking.org/blog/tag/open-networking-foundation

Telecom Service Providers

Value Proposition: Part of the value proposition of this class of vendors is similar to the value proposition of hyper-scale data center providers. For example, these vendors either already are, or are likely to be early adopters of SDN and/or NV in order to support their cloud offerings. In addition, vendors such as Deutsche Telekom, NTT Communications and Verizon are also board members of the ONF.

The preceding chapter of The Guide discussed the interest that IT organizations have in either using SDN in the WAN or in acquiring a service from a WAN service provider that is based on SDN. Responding to that interest, vendors like Pertino[3] are currently using SDN and Network Function Virtualization (NFV)[4] to enable them to offer a new generation of WAN services and Verizon[5] has announced a trial based on using SDN to enable a new generation of data center to data center WAN services.

Representative Members:

- Pertino
- Deutsche Telekom
- NTT Communications
- Verizon

Switch Vendors

Value Proposition: Relative to SDN, the majority of these vendors takes at least some of the control functionality that has typically resided in their switches and now relies on that functionality being provided by an SDN controller. In addition, these vendors implement protocols in their switches that enable those switches to communicate with an SDN controller. These vendors are increasing reliant on merchant silicon as the basis for major portions of their switching product lines.

Most of the vendors in this category represent traditional switch vendors. An exception to that is Pica8. Pica8 provides a switch that is comprised of its network operating system loaded onto commodity white box, bare-metal switches.

Representative Members:

- Alcatel-Lucent
- Avaya
- Cisco
- Dell
- Extreme Networks
- HP
- NEC
- PICA8
- IBM

[3] http://www.pcmag.com/article2/0,2817,2415354,00.asp
[4] NFV was explained in the preceding chapter of The Guide
[5] http://searchsdn.techtarget.com/news/2240182264/Intel-DPDK-switch-and-server-ref-designs-push-SDN-ecosystem-forward

Network Management and Automation

Value Proposition: Most, if not all of the providers of NV and SDN solutions will provide at least some ability for the consumers of those solutions to manage the solutions that they provide. The members of this category of the ecosystem don't provide NV and/or SDN solutions themselves. The vendors listed below either currently provide, or soon will provide management functionality that isn't offered by the providers of the NV or SDN and solutions and/or they integrate the management of these solutions into a broader management structure. The breadth of management functionality provided by the members of this category is illustrated in the next sub-section of The Guide - the sub-section entitled *Representative Vendors*.

Representative Members:

- Packet Design
- QualiSystems
- EMC
- NetScout
- CA

Providers of Network Services

Value Proposition: The members of this category provide network services such as security and optimization that are part of NV and SDN solutions[6]. Some of these services were described in the preceding section of this report. There is the possibility that over time that a large number of independent software vendors (ISVs) will also provide these services.

Representative Members:

- Embrane
- A10
- Radware
- HP
- Riverbed
- Citrix
- Cisco
- Extreme Networks
- NEC

[6] The preceding section of The Guide discussed service chaining/Insertion

Testing

Value Proposition: The members of this category either provide products that enable equipment manufacturers and others to test NV and SDN solutions or they provide the testing themselves.

Representative Members:

- QualiSystems
- InCNTRE
- Ixia
- Spirent

Standards Bodies

Value Proposition: The members of this category create standards for protocols such as OpenFlow or VXLAN. These standards form the basis for enabling products from disparate vendors to interoperate.

Representative Members:

- ONF[7]
- IEEE
- IETF
- Network Function Virtualization (NFV) – under the auspices of ETSI[8]

Providers of SDN or Network Virtualization Controllers

Value Proposition: These vendors provide the controllers that are part of any SDN solution and which are part of many NV and SDN solutions.

Representative Members:

- Big Switch Networks
- NEC
- Nuage Networks
- Netsocket
- HP
- Cisco
- Open Daylight Consortium[9]
- VMware/Nicira

[7] The role of the ONF was discussed in the preceding section of The Guide
[8] The relationship between SDN and NFV was discussed in the preceding section of The Guide
[9] The Open Daylight Consortium was discussed in the preceding section of The Guide.

Providers of Telcom Service Provider's Infrastructure/ Optical Networking

Value Proposition: These vendors are providing the infrastructure that enables telecom providers to leverage SDN in their service offerings.

Representative Members:

- ADVA Optical Networking
- Ciena
- Cyan
- Infinera
- ZTE Corporation

Server Virtualization Vendors

Value Proposition: These vendors provide the vSwitches and the hypervisor vSwitch APIs for third party vSwitches that are a key component of NV and SDN solutions.

Representative Members:

- Citrix
- Microsoft
- VMware

Representative Vendor: Nuage Networks

The Opportunity That Nuage Networks is Targeting

Nuage Networks sees the opportunity to make networks as fluid and responsive as the compute infrastructure has already become, and cloud applications need them to be. Today, data center networks have fallen significantly behind what is required and what is possible. They are operationally complex, restricted and inefficient. Configuration is highly manual, and performed device by device. As they look to turn up new applications, CIOs and IT administrators are encumbered by various tedious networking details that are irrelevant to their broader mission. It all adds up to delays, errors and frustration for users who need their applications turned up. It is simply not an IT-friendly paradigm. In one customer engagement after another, enterprise CIOs demand more agility and higher efficiency. They want to turn up applications and workloads at will anywhere, do it instantaneously and cost-effectively, and do so without losing control & visibility.

Nuage Networks sees value in SDN-enabled automation and virtualization that remove the constraints holding back the network from being as dynamic as the cloud requires. Today, it takes weeks of elapsed time and numerous iterations of work orders between manual processes in order to establish the network connectivity required by virtual machines that come up in seconds in support of application requirements. That is simply not the right thinking for the cloud era. What's needed is reflexive and instantaneous network establishment, in tune with the needs of applications and their administrators and users.

Further, broad-based migration of business-critical applications to the cloud requires more than what we have seen to date with consumer cloud offerings and early public clouds. That is because control and visibility are paramount to IT departments who are committed to ensuring application performance for their workgroups while respecting the security and compliance realities that underpin their business.

The Nuage Networks Value Proposition

With key pillars of programmability through **abstraction** and efficiency through **automation**, The Nuage Networks value proposition is to offer SDN solutions that change the current environment and deliver truly business-grade and hybrid cloud services that pave the way for a true hybrid cloud era. As part of their value proposition, Nuage Networks helps cloud service providers and enterprises make their networks as fluid and dynamic as cloud applications need them to be. Nuage Networks also offers the proper **abstraction** of networking capabilities in a more open environment and the elegant **automation** that makes network connectivity instantaneous in response to application needs, in a policy-based manner.

Functionality Provided by Nuage Networks

To deliver against that value proposition, the Nuage Networks Virtualized Services Platform (VSP) enables programmable and automated network services infrastructure in support of the most demanding virtualized applications across multi-tenant environments.

The Nuage Networks VSP is comprised of three key modules, each of which run as virtual machines (VMs) on standard compute platforms of choice, and participate in one of the three key tiers of the network hierarchy. Collectively they ensure that the Nuage Networks VSP offers enterprises and cloud service providers IT-friendly abstraction of network services needed by applications and policy-based network automation, without compromising control and visibility.

- Within the cloud management plane, the Nuage Networks Virtualized Services Directory (VSD) serves as an advanced policy and analytics engine through which network operators can define the “rules of the game” across slices and sub-slices of network resources offered to tenants or user groups. Through the VSD, permissions and policy can be defined and assigned in a hierarchical fashion, using IT-friendly language and constructs. Once defined, policies can be templated so that they can be easily used many times. In this way, each tier of the role-based hierarchy has full visibility and control within the bounds of their defined scope. This includes access to granular analytics powered by a hadoop engine as part of the Nuage Networks VSD.

- In the control plane, the Nuage Networks Virtualized Services Controller (VSC) serves as a robust SDN controller. Leveraging the principles that underpin scaling of the Internet, instances of the Nuage Networks VSC federate using standard IP protocols to ensure boundless scaling and global network visibility. By peering with DC WAN routers and existing networks, the Nuage Networks SDN controller (VSC) discovers topology and reachability information that enables seamless connectivity within and across datacenters as well as to private datacenters and enterprise locations.

- In the data plane, the Nuage Networks Virtual Routing and Switching (VRS) element extends network endpoint control all the way out to the servers. The Nuage Networks VRS is a hypervisor-resident implementation that provides full layer 2 (L2) through layer 4 (L4) capability for virtualized or bare metal servers, making them fully integrated extensions of a massively distributed virtual routing and switching system under SDN control.

The Nuage Networks SDN approach makes data center and networks more readily consumable, programmable and scalable. It virtualizes and automates any data center network infrastructure, and extends the reach of cloud services to enterprise locations and private datacenters. In that way, cloud services are securely accessible by their users operating in branch or headquarters facilities, and seamlessly integrated across private data centers that house critical data. While eliminating network boundaries, the Nuage Networks solution has been designed to operate seamlessly across operational and organizational boundaries as well.

To deliver the benefits of SDN automation and abstraction to any cloud datacenter, the Nuage Networks SDN implementation accepts the datacenter infrastructure as it stands. Nuage Networks VSP is agnostic to hypervisors, with support for leading hypervisors including KVM, Xen, ESXi and Hyper-V. It is also agnostic to cloud management platforms of choice, including OpenStack, CloudStack, and vCloud Director. Lastly, the Nuage Networks approach is agnostic to networking hardware that is in place such as Top of Rack switches and aggregation/distribution switches. Nuage Networks simply serves to fully virtualize and automate that infrastructure within and across datacenters, and provide seamless connectivity of those assets to enterprise locations, which are already served by VPN services today.

In many cases, incorporating bare metal assets seamlessly into the SDN automation scheme is also an area of great interest and benefit. To that end, in the past quarter Nuage Networks announced further enhancements to the VSP that extend the network automation benefits of SDN to include the full breadth of datacenter assets. In addition to software gateways that have been shipping since Q2 2013 (Nuage VRS-G) and support of 3rd party Virtual Tunnel Endpoint (VTEP) devices through the Nuage Networks **ecosystem of partners** such as Cumulus Networks, we announced the Nuage Networks 7850 Virtualized Services Gateway (VSG) platform. The 7850 VSG delivers a terabit of switching & routing capacity in a single rack unit, an innovative alternative for large datacenters in which the proportion of bare metal assets demands higher performance.

In being among the first of the global network equipment suppliers to appreciate the full potential of the cloud as a transformative technology, Alcatel-Lucent invested over two years ago in key ventures like Nuage Networks and the CloudBand NFV platform that are at the heart of making more agile and programmable cloud networks a reality.

Nuage Networks' Proof Points

Since the launch of Nuage Networks in April 2013, over a dozen trials have been successfully completed with large enterprises as well as cloud service providers and network operators.

Trial customers of the Nuage Networks VSP solution to date include enterprises for whom IT is a critical asset, in key verticals such as financial services, healthcare, or manufacturing. The University of Pittsburgh Medical Center (UPMC) is a representative example of this category of customers. In these trials, enterprises are eager to minimize delays and errors that result from highly manual network provisioning, and to accelerate application delivery to their user groups without sacrificing control and visibility.

Likewise Service Providers with datacenter assets and cloud ambitions are aggressively trialing the Nuage Networks VSP solution, in many cases to develop offers that incorporate datacenter assets as a natural extension of L2 and L3 VPN services they already offer today. Telus (Canada), SFR (France) & exponential-e (UK) are publicly disclosed Nuage Networks trials representative of this category.

Amidst the strong interest in the Nuage Networks SDN solution across all regions of the world, the need for a more fluid and automated network infrastructure that is dynamic but policy-driven in support of multi-tenant and hybrid cloud environments is a common denominator.

More info:
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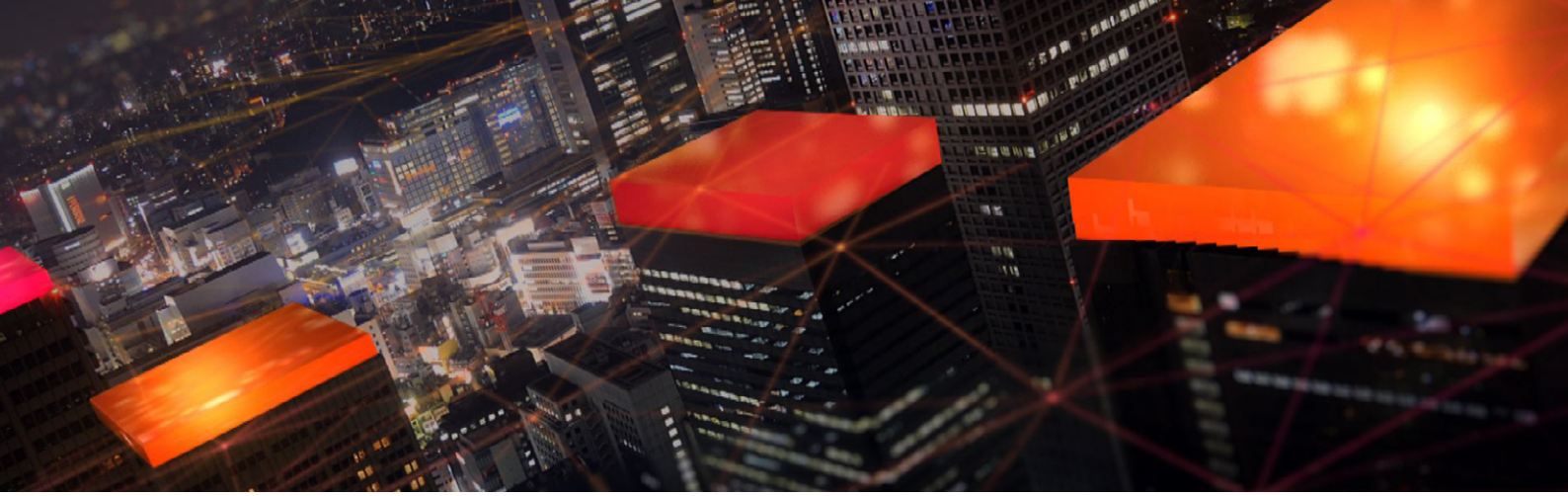


The Consumable Datacenter Network

Taking cloud computing to the next level

The move to cloud computing and storage has changed the way Enterprise users access and consume data. Unfortunately, today's data communications networks aren't keeping pace with this dynamic business environment, and they're struggling to deliver consistent, on-demand connectivity.

That's where we come in. Nuage Networks™ closes the gap between the network and the cloud-based consumption model, creating an infrastructure in which network resources are as readily consumable as compute and storage resources. Our approach enables enterprises to transform the way they build and use their networks, which has a profound effect inside and across multiple datacenters. The transformation is also felt at the critical remote working environment, through a seamless connection to the Enterprise's Wide Area Network.

WOULDN'T IT BE NICE IF...

- Datacenter infrastructures were so simple and standards-based that you could break the vendor lock and work with whichever suppliers offered you the best solutions for your business?
- The network could expand and evolve transparently with the needs of applications, bypassing the datacenter's arbitrary boundaries?
- The datacenter network team could set up controlled, secure templates that application teams could use to deploy applications on the network for and by themselves — without manual transactions or unnecessary project overhead?

Before the move to the cloud, enterprises had to purchase large compute systems to meet the peak processing needs of a limited set of specific events, such as financial milestones (month end or year end), or annual retail events (holiday shopping). Outside of the specific events, the systems were underutilized. This approach was therefore expensive, both in terms of CAPEX and OPEX, requiring significant outlay for power, space and air-conditioning.

Cloud-based datacenters have unshackled the IT environment, making it possible for applications to request additional compute and storage on an as-needed basis. Peak demands can be provisioned "just in time", which lowers operational costs and provides the ability to share compute resources across applications.

The term "cloud" means many things to many people. We focus on two key benefits that cloud computing delivers to Enterprises:

Abstraction of the application from the infrastructure. Cloud computing separates the application from the physical compute and storage infrastructure. This allows workloads to be consistently configured remotely, and templated for mass deployment. End users don't need to worry about the location and specifications of individual hosts. Virtualization and cloud management tools abstract those details to make the infrastructure more readily consumable.

Customer self-fulfillment. Cloud Management Systems (CMS) like Alcatel-Lucent CloudBand™ and the abstraction layer enabled by server virtualization allow IT departments to minimize the tedious and cumbersome processing of application-to-network transactions. For example, IT can provision end customer access policies in the CMS to govern who is authorized to create virtual machine instances, in which location, how many are allowed, and who is the funding department. Users and work groups get instant application deployment, which in turn, makes the business more agile and responsive — critical

attributes in today's enterprise environment. At the same time, operational expenses associated with the handling of work orders is greatly reduced.

As a result of these innovations, Enterprises enjoy a powerful new IT environment in which applications can consume compute resources easily. However as the dynamic nature of cloud computing becomes mainstream, the underlying datacenter network is struggling to match the flexibility of the applications. In fact, most often the network is the weak link, inhibiting the enterprise's ability to profit from the benefits that moving to the cloud should provide.

While virtual compute resources can be instantiated in seconds, it often takes days for network connectivity to be configured and established. Furthermore, the static configurations used by today's networks do not provide the efficiencies and flexibility needed to drive maximum server utilization and application availability.

Consuming the Network

Nuage Networks ensures your network elements are as efficient and flexible as your cloud computing. The result is a choreographed datacenter environment where the compute resources and network work seamlessly.

Imagine the possibilities when network resources are easily consumable. A Nuage Networks datacenter network is as dynamic, automated and virtualized as the server infrastructure, and supports the needs of applications with instantaneous network connectivity.

Nuage Networks eliminates the constraints that have been limiting the datacenter network as it scales out to meet growing demand. With Nuage Networks, you can:

- Define the network service design per application
- Optimize your workload placement across datacenter zones or even across geo-diverse datacenters
- Maximize efficiency of your compute and storage resources

Nuage Networks paves the way for datacenters of the future to be the heartbeat of a powerful cloud infrastructure. Enterprises and user groups could conceive and consume their own secure slices of a robust multi-tenant infrastructure, with appropriate operational visibility and control.

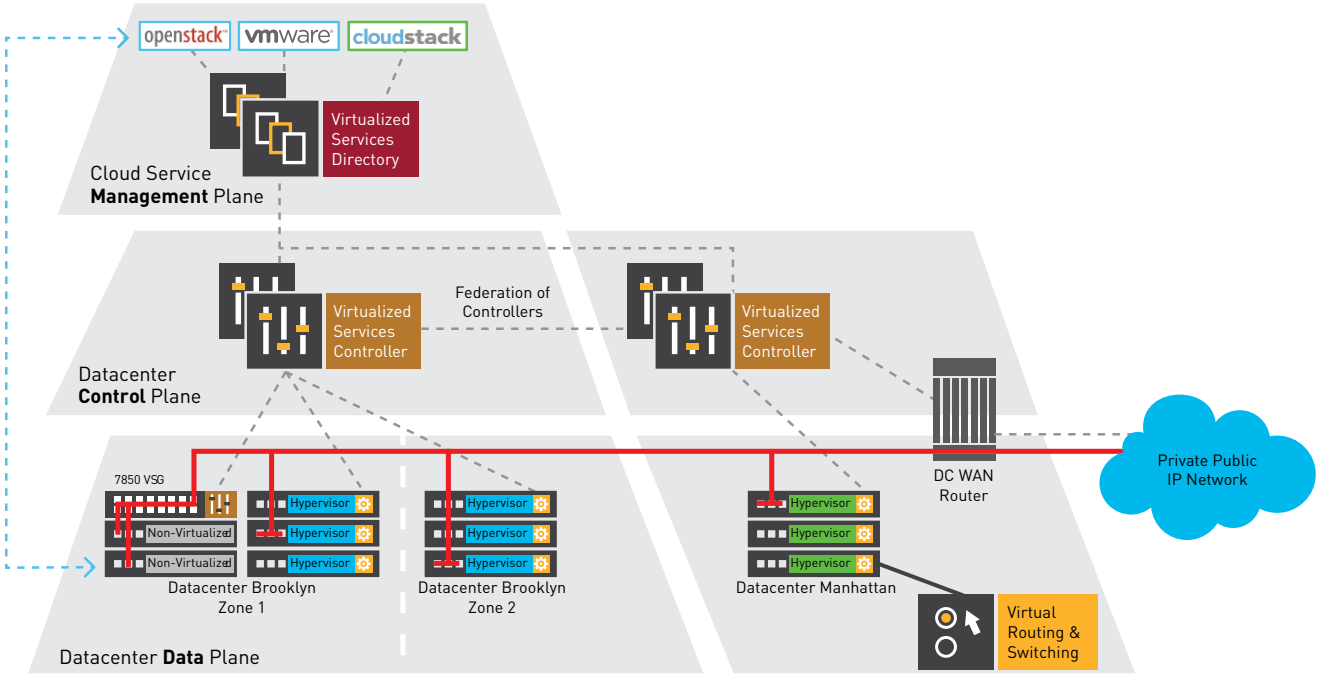
Nuage Networks Virtualized Services Platform

Nuage Networks Virtualized Services Platform (VSP) is the first network virtualization platform that addresses modern datacenter requirements for multi-tenancy, full-featured routing and security at scale. It also integrates seamlessly with wide area business VPN services. It is a software solution that transforms the physical network into a simple to manage, rack-once and wire-once, vendor-independent IP backplane. As a result, network resources within and across datacenters can be treated as an elastic resource pool of capacity that can be consumed and repurposed on demand. Nuage Networks enables unconstrained datacenter networks for the cloud era.

Nuage Networks delivers virtualization and automation of business networks through the three key elements in the Nuage Networks VSP:

Virtualized Services Directory (VSD). Configuration of networks is complex. To eliminate unnecessary complexity while leaving full control and visibility of applications with the IT administrator, the VSD abstracts networking constructs down to their base primitives in four categories: Connectivity Domains, Security, Quality of Service, and Analytics. This allows the requirements for network services to be expressed simply,

FIGURE 1. Nuage Networks Virtualized Services Platform



consistently, and in a repeatable manner. The critical need for mobility is also addressed, ensuring network services adjust gracefully and instantly as application endpoints and workloads move from virtual machines within or across datacenters.

The VSD also provides a rich permission-based multi-tenant interface to enable end user provisioning by application owners. Through its role-based hierarchy of permissions, the VSD eliminates operational delays and minimizes transactions between organizations while providing visibility and control of the network "slices" that each group is given in support of their application requirements.

Virtualized Services Controller (VSC). The VSC is an advanced SDN controller that manages the provisioning of virtual network services by programming the edges of the network using OpenFlow™. The VSC ensures that the network follows the application instantaneously. Parting with cumbersome and error-prone device-by-device manual provisioning, Nuage Networks introduces an event-triggered and pull-based configuration model. Once application events such as moves, adds or changes are detected, appropriate policy-based configurations are instantaneously applied. Leveraging Alcatel-Lucent's proven Service Router Operating System, which has been deployed in over 400 service provider networks worldwide for over a decade, the VSC runs a full and robust IP routing stack that allows it to communicate and seamlessly integrate into existing networks.

Virtual Routing and Switching (VRS) is a true hypervisor for the network. The first of its kind in the industry, the VRS fully virtualizes network offerings ranging from distributed virtual Layer 2, Layer 3 forwarding and Layer 4 security. These virtual network services leverage the existing network infrastructure and are offered in a standards-based manner compliant with IETF NVO3. Operators can use whatever servers, hypervisors, and cloud management systems they choose; the Nuage Networks solution abstracts and automates the cloud-networking infrastructure.

In many real-world installations, datacenter environments are a mix of virtualized and non-virtualized assets. To help all datacenters benefit from automation and network virtualization, Nuage Networks supports the full range of options. Software gateways such as the Nuage VRS-G are ideal for environments with relatively low density of bare metal servers and appliances, just as hardware VTEPs from our ecosystem partners provide a viable alternative for certain use cases and environments. For environments with significant investment in bare metal servers and appliances, a new breed of high performance gateway is needed.

The **Nuage Networks 7850 Virtualized Services Gateway (VSG)** is a high-performance gateway that extends Nuage Networks SDN 2.0 functionality seamlessly between virtualized and non-virtualized assets in the datacenter. Working in concert with the Nuage Networks VSP, policies devised for applications automatically extend across virtualized and non-virtualized assets for a fully automated network infrastructure.

FIGURE 2. Nuage Networks datacenter network benefits

	Status Quo	NUAGE NETWORKS DELIVERS What is Needed
Virtualization of network services	LAYER 2 VIRTUALIZATION	FULL NETWORK VIRTUALIZATION, L2 THROUGH L4
Breadth of application models	SIMPLE SCENARIOS	HYBRID CLOUD SERVICES, SEAMLESS VPN CONNECTIVITY
Availability & scale	FRAGILE, NOT MULTI-TENANT	ROBUST, THOUSANDS OF TENANTS
Reach & mobility of network resources	ISLANDS, WITHIN RACKS OR CLUSTERS	SEAMLESS VIRTUALIZED FABRIC, THROUGHOUT & ACROSS DATACENTERS
Network service turn-up time	SLOW, MANUAL, CONFIGURATION DRIVEN	INSTANTANEOUS, AUTOMATED POLICY-DRIVEN
Openness	SPECIFIC TO VENDOR IMPLEMENTATIONS	INDEPENDENCE FROM HARDWARE CHOICES
Breadth of assets automated	VIRTUALIZED ASSETS, LIMITED OPTIONS FOR NON-VIRTUALIZED	ALL DATACENTER ASSETS, VIRTUALIZED & NON-VIRTUALIZED

NU•ÂHJ: FROM FRENCH, MEANING "CLOUD"

The cloud can be more than what it is. In fact, it needs to be. When we founded Nuage Networks, it was with the idea that it's time for the cloud to come of age. From the beginning we recognized the unique challenges that cloud service providers and large enterprises face delivering and managing large, multi-tenant clouds. While the virtualization of compute and storage has evolved quickly, the network simply has not kept up. The result is that today your cloud is being held back. And so is your business.

When we started Nuage Networks, it was with the mission that we could empower our customers to finally deliver on the true promise of the cloud. We envision a world in which IT and IP are no longer in conflict, but rather work in concert to propel your business and elevate the cloud for every one of your customers. We see a world where innovation isn't hampered by infrastructure, and network resources are as effortlessly consumable as compute and storage.

To make this vision a reality, Nuage Networks brings a unique combination of groundbreaking technologies and unmatched networking expertise. This enables us to create solutions that do more than provide incremental improvement. It allows us to introduce radically new thinking and pick up where others have left off, delivering a massively scalable SDN solution that makes the datacenter network able to respond instantly to demand and boundary-less.

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