

EXECUTIVE SUMMARY

The principles of cloud computing are transforming the information services landscape pervasively. Every application and industry sector is embracing the model in its own way, and uptake of cloud-based solutions is projected to continue and expand in coming years. Cloud models have also gained the attention of the networking community, with service providers, enterprises and product suppliers globally investing heavily in developing solutions that leverage the virtualized and broadly automated designs of the cloud. Innovations in SDN and NFV are leading those transformations.

In the recent past, one domain that has emerged as particularly ripe for transformation is networking for enterprise branch and distributed sites. Solutions based on the principles of the cloud are poised to bring order of magnitude improvements in both TCO and RoI in branch network services for enterprises and for service providers providing network and IT services to enterprises.

But not every solution providing virtualized implementations is capable of bringing the full advantages of the cloud to branch and distributed site networks. They fall short of leveraging the cloud on one or more dimensions. By contrast, Nuage Networks has taken an innovative and visionary approach to enabling branch and wide area network users with its Virtualized Network Services (VNS) solution. Fully grounded in the virtual networking and service automation principles employed in its VSP solution for cloud data center deployments, VNS enables the pervasive agility and innovation advantages both enterprises and service providers expect to obtain from their cloud-based applications and services.

Report Highlights

- Virtual networking innovations are bringing an entirely new experience to enterprise network services
- Virtualized services regularly enable 60-80+ % TCO improvements over PMO
- RoI of virtualized solutions is consistently 100+ % better than PMO
- The open architecture of VNS allows for a flexible mix of applications, services and infrastructures to every enterprise deployment
- VNS extends an enterprise's reach to global scale with 'deploy anywhere' agility
- VNS' visionary open policy architecture enables a 'one cloud' experience across branch, WAN and data center sites, with secure access to applications everywhere

Ubiquity of the Cloud

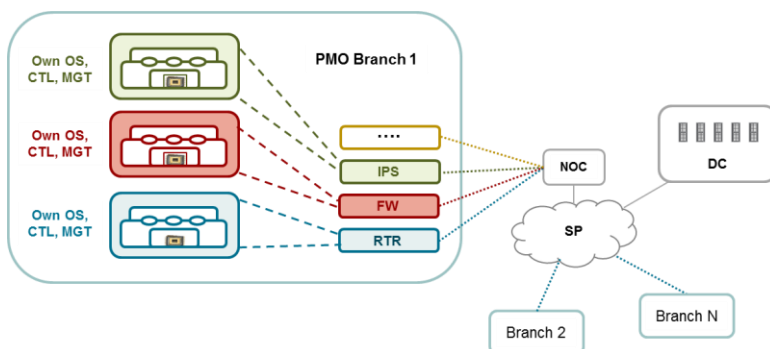
The remarkable versatility of cloud-based services has ushered in a massive transformation in the way information services are delivered and consumed. Analyses show that over 50% of the world’s workloads are running in a cloud service delivery environment of one type or another today (private, hybrid or public), and in five years’ time that number is projected to exceed 75%.¹ The advantages of the cloud model have been demonstrated in both consumer and business applications, and use cases will only continue to expand with addition of a practically uncountable number of endpoints in the internet of things. The positives of the cloud’s virtualized and highly elastic architectures have been broadly demonstrated in the compute and data center domains. There is no turning back.

Adoption of the Cloud in Virtual Network Infrastructures

The advantages of the cloud’s virtual infrastructure model have also generated strong engagement in the networking community and are stimulating a range of innovations that embrace it. Two dimensions are most heavily engaged. First, extensive developments have occurred adding versatility to networks and the cloud via programmable, or software-defined networking (SDN) methods. And second, a parallel, equally broad initiative has been taken up to transition value-adding services such as firewall protections and deep packet inspection for rule-based forwarding and traffic analysis, to a model based on the cloud, under the umbrella of Network Functions Virtualization (NFV). Via these initiatives, service delivery networks are going virtual on many dimensions, again with no turning back.

Opportunity in Enterprise Branch and Wide Area Networks

One important area of network deployments that has been slow to change over the past five to ten years, and which is rapidly emerging as a candidate for improvements based on virtual designs, is networking in enterprise branch offices and distributed sites. In a manner similar to the data center infrastructures that gave rise to the cloud, branch and distributed sites in enterprises are ripe for the flexibility, efficiency, and elasticity the cloud model supports.



In their present mode of operation (PMO) enterprise branch networks are comprised of one or more purpose-built, closed, relatively costly devices that support their basic operating needs (VPN access, Internet access, additional network or application services). Deployments in the PMO are generally performed on

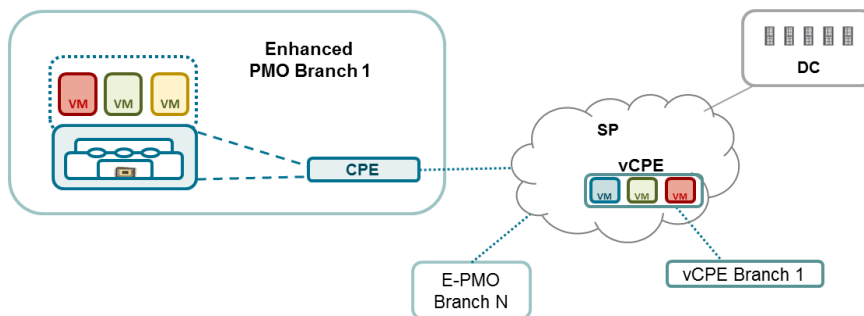
a ‘box per function’ model. Each ‘box’ (router, firewall, WLAN controller, etc.) is self-contained, run on

¹ Aggregation of ACG and additional industry research.

proprietary hardware and software, and requires its own management approach (command line interface, scripting, element management system, etc.). Over time operators have found the PMO to be cumbersome to operate, slow and expensive to evolve, and incapable of adapting rapidly to the emerging demands of users and the business for new applications, devices, communication patterns, and efficiency in support. Like the data centers that incubated the cloud model before them, enterprise branches are ripe for a new design. Evidence to date shows there is ample upside to motivate it. Research we and others have done on a number of cases shows the total cost of ownership (TCO) of a virtualized branch to range from 50 to 80% lower than the TCO of comparable PMO, and the RoI of virtualized offerings for a service provider to be an order of magnitude better than PMO (regularly 100% better or more).²

Profile of a New Operating Model

Several approaches to implementing a virtual branch have emerged in recent industry work. In the ETSI NFV Industry Specifications Group, for example, virtual enterprise CPE deployments have been identified as among the more attractive near term use cases to address. Most approaches developed to date employ software-based functions running in virtual machines allocated to the branch in one way or another. Variations on the model include VMs running as strictly local embellishments to an otherwise purpose-built networking device installed at the enterprise site (representing a modest enhancement to PMO), and branch services running in the operator’s infrastructure in a pool of VMs located there.



While each of these improves to some extent on the PMO of closed and cumbersome solutions, they fall short of the capturing the full benefits of a cloud-based solution that provides even more flexibility, and is fully integrated with the broader cloud environment. In our opinion, Nuage Networks Virtualized Network Services (VNS) is an early-to-market and leading example of such a fully cloud-enabled solution.

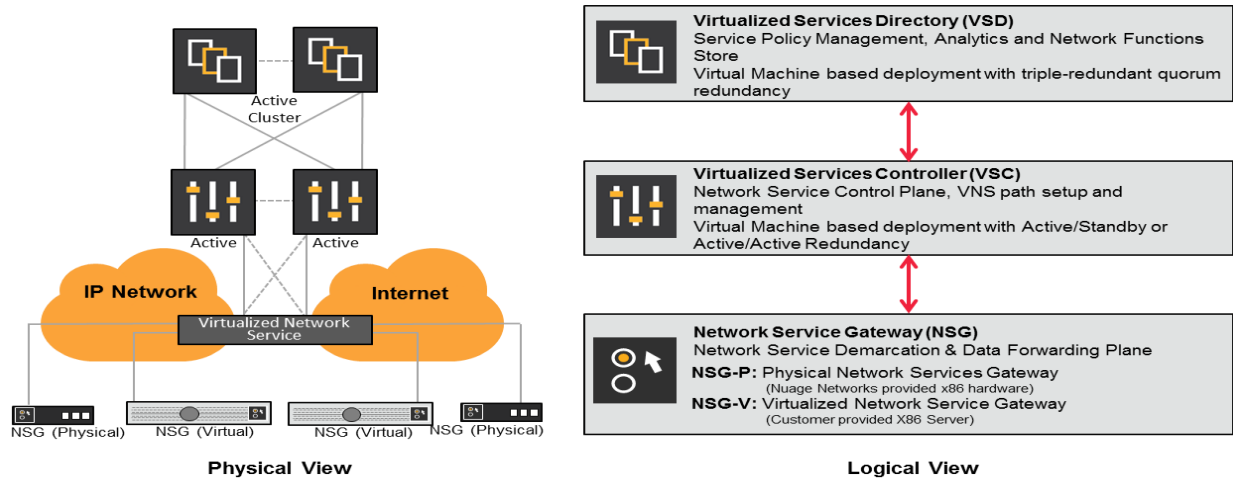
Let’s look at the elements of the environment and determine why this is the case.

VNS employs the principles of the cloud running on general purpose hardware, allowing installation in small, medium and large enterprise sites as well as VM pools within the operator’s cloud, if preferred.

Additionally, VNS software is open on a number of dimensions that matter significantly in the cloud. Its virtual routing and switching functionality – the component that provides networking services to each

² ACG Research, ‘Business Case for Virtual Managed Services’, October, 2014.

workload expecting to run in the network – is agnostic to the hypervisor employed. Services can be enabled in KVM, Xen, and ESXi environments. Linux containers and bare metal servers are also supported. This range of platforms for VNS provides valuable flexibility in designing a deployment.



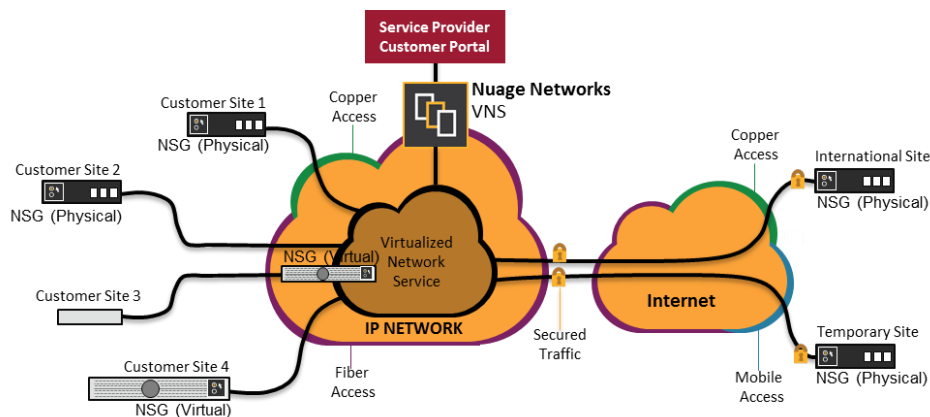
Virtualized Network Services (VNS) Solution Architecture

VNS is also open northbound, allowing policies for applications and services to be imported and applied from OpenStack, CloudStack, and VMware vCloud Suite orchestration systems. Support for this range of orchestrators allows VNS to be used in an array of enterprise deployments across an SP’s overall customer base, or for different portions of a single enterprise’s deployment.

Pervasive Agility: Realizing the Full Promise of the Cloud

While these capabilities are attractive, there are additional elements of the Nuage implementation that more fully distinguish it from other solutions.

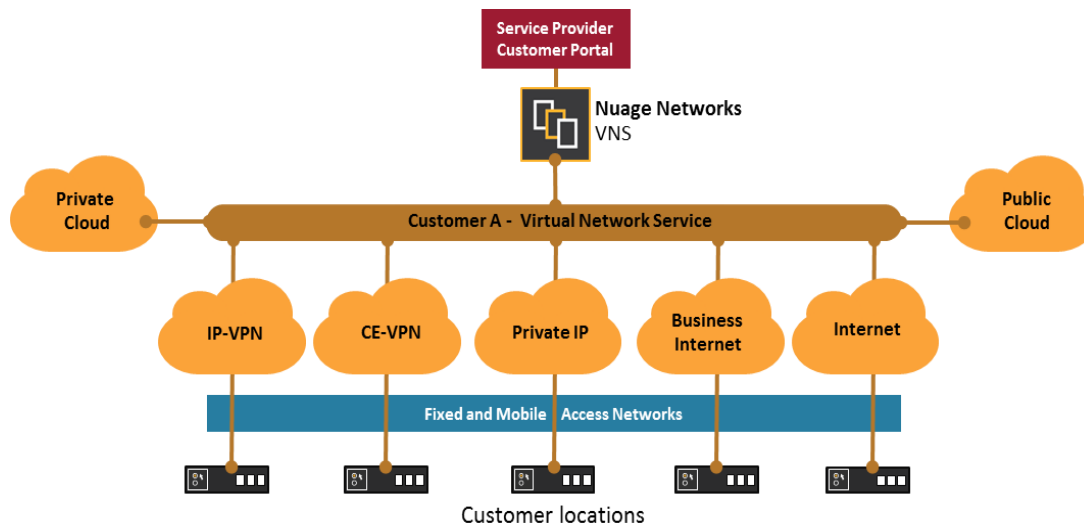
First is its ability to ‘deploy anywhere’. This is based on a VNS ‘site’ being a collection of virtualized functions that can be deployed in VMs anywhere and securely integrated with the other VNS nodes in



an overall deployment over IP Sec (or other encapsulations and links). ‘Anywhere’ in this case can be taken literally: it can be in another SP’s infrastructure on another continent, or in an enterprise

location at a distant site. In this sense VNS embodies the ‘NFV as a service’ model envisioned in the ETSI NFV ISG community, and extends the reach of an enterprise’s IT services significantly.

Second is that VNS enables policy continuity across domains. While simple in concept this is not as simple in reality to achieve. It is especially valuable in a distributed, cloud-based service. The benefit of this is that policies that apply to a given user (access rights, for example), or to an application (resource capacities, for example) can be defined and managed in a unified manner between data center and wide area or branch resources - for all intents and purposes, on an end-to-end basis. In some environments an implementation approximating these outcomes can be stitched together from separately cooperating solutions. However in such cases, separately provisioned resources must be brought together ‘in the middle’ via person-to-person coordination, as with a baton handoff in a relay race. With VNS, if a Nuage Networks solution is running in the data center, WAN and branch, alignment of policies is automatically coordinated, since policy is managed from a single logical policy source across multiple network controllers.



Finally VNS is able to deploy its services at large scale, which is crucial for service providers and the enterprises they support. This is substantially enabled by federating the solution’s Virtual Services Controllers (VSC, VNS’ abstracted control plane component). Because VSC employs MP-BGP based on Alcatel-Lucent’s widely deployed SR-OS routing software, a VNS deployment can function as a federated network with scaling beyond the limits of many other SDN solutions.

Deployment Models and Use Cases

With its flexible and scalable architecture, VNS enables a number of deployment models and use cases. Where the customer prefers, a VNS gateway can be deployed on general purpose servers at customer premises. The number of services deployed (FW, NAT, secure-VPN, etc.) is a menu and auto-provisioning choice for each customer’s needs. Whether the premise is a small branch or a larger operating site, capacity can be allocated from VM pools on the appropriate number of servers. In a

similar manner, a customer's network can be run from inside an operator's cloud on resources in a variety of infrastructure locations. VMs could run in distributed compute PoDs located close to customer endpoints, or could run in the operator's cloud data center elsewhere in the infrastructure. And where the enterprise is widely distributed across countries or continents, VNS gateways can be deployed in secure VMs in remote operator systems (for example, where a Latin American site for an enterprise is supported by VMs in a local operator's infrastructure, and the customer's headquarters operation is based in a Canadian location). All of these models employ the same scalable, synchronized, and unified policy and control solution using VSC and the centralized policy control point of the Nuage Networks Virtualized Services Directory (VSD) in a single deployed enterprise service.

Benefits for Operators and Their Customers

Because of its extensive embrace of cloud design principles, VNS is positioned to bring unique benefits to operators' enterprise network offerings. VNS brings great flexibility to designing offerings for enterprises in a range of sizes and geographies. This may bring access to revenues not previously available to many SPs, stimulating business services growth. In addition, because of VNS' open software design, it creates opportunities for innovation in service offerings, helping operators appeal to customers in different segments, again stimulating revenue growth. And as we noted previously, VNS is designed to leverage a substantially more cost-efficient infrastructure than the PMO employs. By using general purpose hardware, open software, a consistent framework across domains, and extensive automation of policy deployments, VNS can enable order of magnitude reductions in TCO and improvements in RoI for operators of many sizes.

Operators' enterprise customers stand to gain accelerated access to new innovations based on VNS' cloud implementation model, increasing their efficiency and competitiveness. And incorporating distant locations not reachable before with a consistent architectural framework, based on VNS' 'deploy anywhere' functionality, will help them strengthen their overall effectiveness.

Conclusion

By taking the innovative step of applying the principles of the cloud, where Nuage Networks has already demonstrated its capabilities, to the needs of enterprise network services, Nuage Networks has created a compelling solution poised to unlock new benefits for enterprise customers and the service providers supporting them. With its architectural consistency across cloud and branch, its 'deploy anywhere' reach, its efficient use of open and general purpose infrastructures, and its broad integration into service orchestration frameworks, VNS is poised to bring unmatched agility and differentiation into operators' enterprise networking and related cloud-based services.