Clouds at the customer edge

This case study describes a global leader in cloud infrastructure and hosted IT solutions for enterprise customers. The service provider is an S&P 500 company and is included among the Fortune 500 list of America's largest corporations.

Business benefits

Competitive advantage in services delivery

The company's ability to deliver "any service, anytime, anywhere, for anyone" has not been matched by its competitors. By being first to reach this goal, the company is able to meet each customer's unique requirements — a key advantage in a fiercely competitive market. As a result, the company benefits from a faster time-to-revenue and higher customer satisfaction.

Leverage current best practices for operations

Software Defined Networking (SDN) changes the operational model by enabling sophisticated multi-step automation workflows. The architecture the company designed uses existing skill sets and best practices for operations. The company is able to leverage its current approach while realizing the benefits of SDN, ensuring that over both the short and long term operations will remain smooth and uninterrupted.

Advantage in services creation and pricing

By moving network functionality from purpose-built hardware appliances to software running on a shared x86-based platform, the company can more rapidly iterate and perfect the services it offers. Further, by using industry-standard hardware that conforms to Moore's Law, the company is realizing both time-to-market and infrastructure cost advantages.

"Any service, anytime, anywhere, for anyone"

The company's core mission is to address the diverse connectivity and cloud service needs of the large and small-to-medium enterprise market segments. Its strategy is visionary — to deliver "any service, anytime, anywhere for anyone." Rather than just offering compute and storage in the cloud as a "me-too," the company is providing businesses with a complete cloud environment that pushes valuable services where they are most needed and efficient — at the edge of the network. Its challenges included:

- Balancing a visionary goal with a pragmatic approach in which progress is made in stages without disrupting current operations
- Leveraging existing legacy networking skill sets and operational knowledge for the new cloud architecture
- Unifying the customer experience with a single portal that hides the complexity of the disparate legacy and acquired IP and WAN networks
- Supporting cloud platforms (OpenStack), containers and open source development environments
- Breaking the design into steps to learn what the company didn't know and operationalizing what they learned along the way

The approach

The company decided to break its journey to the cloud into discrete steps. Each step would provide the company with the base infrastructure and core lessons needed to tackle the next step.

Step 1: Provide "any service" — including public cloud — to the customer

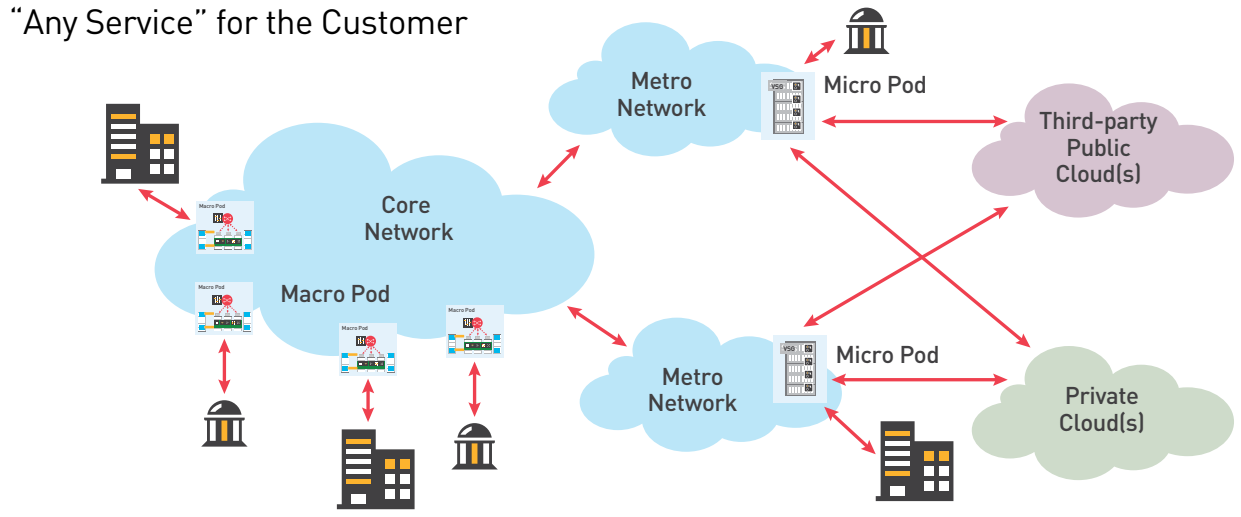
The company's infrastructure spans multiple major networks from organic growth and acquisitions. As a result, unifying services across multiple IP networks is a priority. The company also wanted the capability to leverage both its own private clouds and third-party public clouds in solutions for customers.

To provide these capabilities in a cloud context, the company created a pod design ("Macro Pod") that combined compute, network and storage into a discrete unit for the computing needs of its customers. Another Pod design ("Micro Pod") adds network gateway capabilities.

As shown in Figure 1, the Macro Pods provide a consistent platform to deploy Virtualized Network Functions (VNFs) near the edge of the network to meet the performance needs of customers and limit backhaul of large centralized datacenters. Similarly, Micro Pods were placed closest to the private or public clouds with which they communicate.

The disparate networks were then unified ("federated") into a single network entity using SDN from Nuage Networks™. Nuage Networks Virtualized Services Platform (VSP) is a pure software network overlay that works with the existing network hardware underlay. By interconnecting all networks into a coherent and manageable whole, services that span from the customer premises to even a public cloud were made feasible. This capability maximizes the company's ability to address the most demanding customer needs in terms of desired services and solutions on a global basis.

FIGURE 1. The company enables any service to be delivered — dedicated, private cloud, and even public cloud



Step 2: Create delivery vehicle for "anytime" programmability

Once a unified network was created, the next step was to make it programmable. The network provides end-to-end command and control capabilities. To enable full network control, it interfaces with a number of key operational systems and vendor components including Nuage Networks VSP in a configuration that spans technology boundaries between networks.

Figure 2 shows how the Nuage Networks VSP overlays the physical network. A key component of the platform, the Virtualized Services Directory (VSD) provides a centralized set of network policies which are applied intelligently at each network point in the Pods and in network gateways. This approach provides consistent and automated network management to reach VNFs from network segments of widely varying origin. Implementations of the Nuage Networks VSD are placed where needed — such as in network operations centers and in major datacenters worldwide.

Another Nuage Networks VSP component, the Virtualized Services Controller (VSC) — located in each Macro Pod — provides real-time switching and routing information throughout the network. The Nuage Networks Virtualized Services Gateway (VSG) virtualizes bare metal servers and acts as a gateway to external clouds. The Virtual Routing and Switching (VRS) component is installed in each virtualization hypervisor and provides efficient, secure switching among VNF virtual machines (VMs) and to wide area network services external to the Macro or Micro Pod.

Nuage Networks Virtualized Services Assurance Platform (VSAP) correlates the virtualized overlay to the physical equipment underlay throughout the network for full stateful inventory visibility, real-time monitoring and automated root-cause analysis. VSAP is composed of a server element tied to the appropriate VSD and monitoring elements (not shown) using standard routing protocols (ISIS, BGP) to record the history and state of each overlay service and underlay control plane event.

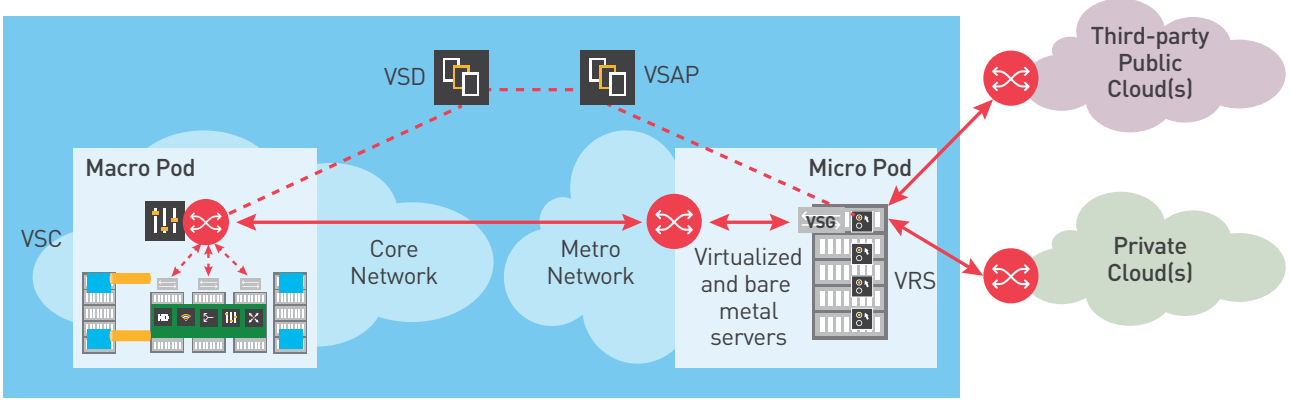
With end-to-end connectivity as well as visibility, the network enables full end-to-end programmability capabilities — from the WAN through the Internet and among both private and public clouds. The network is capable of elastic, real-time responses to provision, change and move requests submitted by the customer or by the network administration team. With this capability, the company can ensure customers receive flexible, real-time responses to their needs.

Why Nuage Networks

Each step relies on unique capabilities of Nuage Networks products:

- **"Any Service" –** Only the Nuage Networks VSP federation capabilities can unite multiple, disparate networks into a coherent, programmable whole. This unified network forms the foundation for the entire cloud architecture.
- **"Anytime" –** Rich integration capabilities, including a REST API, enable OpenStack, cloud orchestration platforms and the unified portal to work with the network in parallel and in real time. By making the entire cloud programmable, the company has full freedom to design and implement customer-pleasing services of all varieties.
- **"Anywhere" –** Sophisticated automation capabilities, including service chaining, provide secure instantiation of even the most complex network services anywhere in the world. A rich set of security functionality — including automated policies, zero trust and micro-segmentation — is applied across the entire environment consistently and provably by Nuage Networks VSP.
- **"For Anyone" –** The ability of the Nuage Networks VSP to virtualize bare metal resources along with its rich integration capabilities enables even SMB markets to be addressed with a self-service approach. This enables the company to win new markets and helps stave off competition from public cloud giants.

FIGURE 2. The network provides full programmability in real time



Step 3: Enable automated and secure access from "anywhere"

The company offers its customers a portfolio of value-added services (VAS). Each service can be provisioned in real time based on a new customer request or a request for an increase in an existing service. A service is typically composed of one or more VNFs. VNFs are currently packaged into VMs but could also be packed into Docker containers. For elasticity, isolation and convenience, each customer's VNFs are provided via dedicated VMs. With this approach, more VNF capacity can be spun up in real time in response to a customer request or a workload demand.

When making VNFs available to both cloud and traditional WAN Virtual Private Network (VPN) customers, two top concerns are operational complexities and security. As shown in Figure 3, customer premises equipment (CPE) appliances communicate via the provider edge (PE) over an MPLS network to a virtualized router, the Nokia Virtualized Service Router (VSR). The VSR provides encapsulation into secure VXLAN or VPNoGRE tunnels that connect with the VRS agent in the Nuage Networks VSP. The VRS agent then communicates with the VRFs in the VMs that are dedicated to each customer.

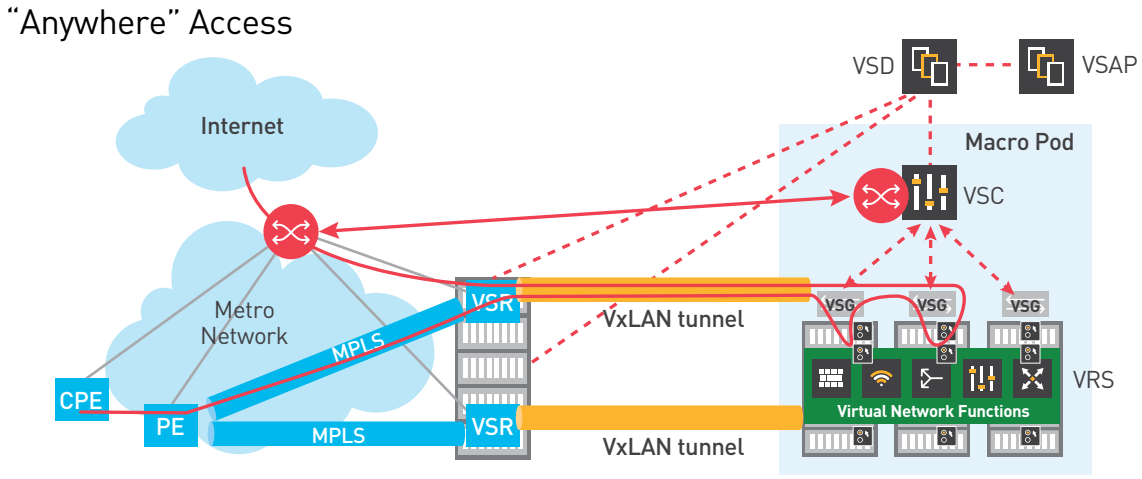
From an operational perspective, the Nuage Networks VSP policy-based automation provides end-to-end access. Rather than relying on fixed parameters such as IP addresses, the Nuage Networks VSD manages a single policy intelligently interpreted at each endpoint shown in Figure 3. Further, service chaining capabilities enable complex, multistep provisioning processes to be defined and executed step by step within and across physical networks.

To make this approach work in a diverse environment, endpoint reachability is advertised between networks via a well-understood industry-standard protocol — BGP. Nuage Networks VSAP enables existing problem determination and isolation processes to be used. As all this functionality leverages the existing knowledge and practices of the company's operations team, operational impacts are minimized.

From a security perspective, customer isolation begins at the CPE and extends all the way to the private or public cloud. Security measures include industry-standard encapsulation protocols (VxLAN and MPLS) and traffic isolation via VxLAN or VPNoGRE overlay tunnels. Security within the Pod is provided through a default "zero trust" security policy and complete isolation of VM-to-VM communications on the same hypervisor via micro-segmentation capabilities. As discussed above, since a single policy is intelligently and consistently interpreted at each device or endpoint, a consistent, provable security framework is applied from the WAN VPNs through the Macro Pod or Micro Pod and to each public or private cloud. Further, "bump in the wire" and "elephant flow" capabilities enable either every packet or every flow to be inspected by third-party security appliances, respectively.

Summing up, the service provider is enabling secure access from anywhere to anywhere, both on its own networks and public clouds. By connecting endpoints on the customer's premises to Pods and external public clouds, the company provides solid performance, complete automation, and high security while realizing the benefits of consolidation into a highly tuned converged infrastructure. With this approach, the company's performance and flexibility easily rival or beat a customer's in-house capabilities anywhere in the world.

FIGURE 3. Service delivery from an edge-based Pod or datacenter with access from anywhere



Step 4: Provide value added services in real time "for anyone"

In addition to operational and security advantages, full automation enables the company to address both enterprise departmental and small-to-medium business (SMB) needs. The company provides a unified portal to its customers that both masks the complexity of the infrastructure and allows self-service provisioning and de-provisioning requests to be processed in real time.

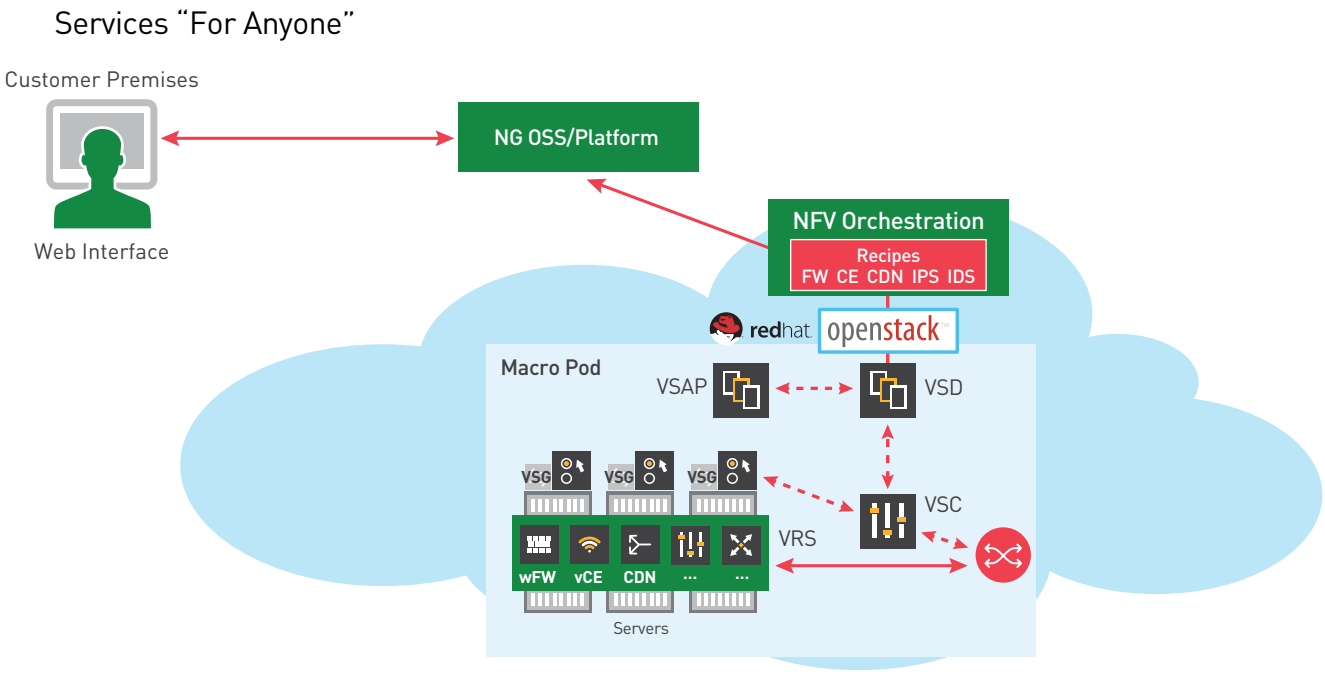
As shown in Figure 4, a customer request for a VAS is made via the unified portal and passed to the NFV Orchestration layer. The NFV Orchestration layer either invokes the Red Hat Enterprise Linux OpenStack Platform or Nuage Networks VSD directly. Server and storage requests are typically handled by the Red Hat Enterprise Linux OpenStack Platform. For networking requests, the Nuage Networks plug-in to the OpenStack Neutron networking framework provides the necessary linkage.

Nuage Networks VSD retains the master recipe catalog of abstracted networking policy templates for the service types and VNF connectivity combinations available in the Micro or Macro Pods. The recipe contains the code and specifications for each VNF utilized by the requested service. Templates for network configuration are then automatically put in place using sophisticated service chaining capabilities within the Nuage Networks VSP and made available to the customer as described in Step 3. VNF examples shown are a virtual firewall (vFW), a virtual Customer Equipment (vCE) appliance and a Content Delivery Network (CDN).

Nuage Networks VSP relies on policy-based provisioning of connectivity as VNF VMs are instantiated and interworks seamlessly with existing WAN and cloud networks. Automation gains at this level allow for the instantaneous self-service adds/moves/deletes that customers of all sizes crave. This self-service approach will not only differentiate offerings from its current competitors but also help stave off the public cloud giants.

In this fashion, the company achieves a win-win in terms of automating the entire process in real time, achieving centralized efficiencies and realizing edge-based performance benefits. Most importantly, since the entire process can be provided in a self-service model, any size customer — from a Fortune 500 enterprise to an SMB — can be served with this approach.

FIGURE 4. Providing real-time service deployment for any size customer



About Nuage Networks

Nuage Networks (www.nuagenetworks.net) brings a unique combination of groundbreaking technologies and unmatched networking expertise to the enterprise and telecommunications industries. The Silicon Valley-based business has applied radically new thinking to the problem of delivering massively scalable and highly programmable SDN solutions within and across the datacenter and out to the wide area network with the security and availability required by business-critical environments. Nuage Networks, backed by the rapidly growing IP/Optical Networks business of Nokia, has the pedigree to serve the needs of the world's biggest clouds. The cloud has made promises – the mission of Nuage Networks is to help you realize them.

With a relentless focus on customer needs, the company is executing an aggressive cloud transformation one step at a time. This fundamental architectural shift will pay for itself based on the initial services deployment alone — with even more differentiated services on the horizon.

How this approach changes the game

The innovative approach described here helps the company differentiate its services for its customers and from its competitors. New capabilities include:

- **Elasticity based on virtualized services.** Since the value-added services are composed of VNFs housed in VMs or in Docker containers, they can adapt in real time to changing workloads. Should demand for a particular VAS rise, more VNF components can be automatically instantiated to meet demand.
- **Deploy services and VNFs where optimal.** The company can host VASs and VNFs in any rack or Pod that is accessed from any point in the IP or WAN network. This capability enables cost-effective consolidation across customers and regions.
- **Pods for high resilience and performance.** Pods are architected to route around hardware failures and can be expanded non-disruptively. This enables a cloud approach but provides performance advantages from being close to the customer.
- **Unparalleled customer experience.** With this approach, a single customer portal can access, interact with and control datacenter and WAN services distributed across a complex network configuration. The customer experience is enriched by masking the complexity of the physical infrastructure with a user-friendly interface.
- **Unmatched end-to-end security.** In most cases, network unification increases the exposure surface of the architecture. Nuage Networks VSP, however, leverages sophisticated security capabilities including micro-segmentation, a default zero trust policy and intelligent policy interpretation at each endpoint. This reduces the exposure surface overall while eliminating security exposure caused by manual errors.
- **Leveraging Moore's Law.** Instead of high-power compute servers, each compute Pod contains a relatively large quantity of lower-cost white box servers that are automatically removed from service at failure. Since industry-standard hardware evolves much faster than name-brand gear, price-performance ratios will provide a competitive advantage automatically with each new refresh. This puts the company on a path to compete not only with service innovation but also on price as needed.
- **Platform for the future.** The architecture is implemented with OpenStack. It fully supports containers and emerging open source development environments (such as Mesos and Kubernetes) that provide incredible flexibility and power for future efforts.

Adding it all up

The service provider is solving a problem that it could not solve with legacy technology. It is providing services traditionally distributed to each customer site (such as a branch office) to meet performance requirements, but it is doing so in an architecture that is concentrated at a district or regional level. This enables the company to capitalize on economies of scale. By leveraging SDN from Nuage Networks and the Red Hat Enterprise Linux OpenStack Platform, the company is able to take full advantage of its existing network teams and expertise in a way that gives it both a functional and cost advantage. As a result, the company is winning today as many of its competitors are standing still. Furthermore, the company is paving the way to widening the gap in the near future.

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