Orchestrating Dynamic Enterprise Services

Overcoming the Challenges of SD-WAN and vCPE Mass Deployment

Executive Summary

In order to adapt to changing customer expectations and increasing competition from a new generation of cloud and content-based service providers, network service providers are evolving their static, purpose-built networks into dynamic, agile ones based upon software defined networking (SDN) and network function virtualization (NFV) technologies.

One of the leading early use-cases for SDN/NFV technology is the migration of purpose-built, hardware-centric enterprise business services to virtualized, software-centric, Dynamic Enterprise Services via SD-WAN and virtual CPE (vCPE) deployment options (refer to Appendix A for definitions). Industry leading virtualization solutions enable enterprise functions such as routing, security and service enablement to be instantiated easily and on-demand with common hardware at the customer's premises, in the data center or in a hybrid configuration. SD-WAN services are deployed as a network overlay while vCPE services are typically deployed in conjunction with the physical underlay. As service providers look to move Dynamic Enterprise Services beyond proof of concepts (POC) and trials and into mass commercial deployment, they face a myriad of business, technical, operational and organizational challenges. The challenges to network service providers have never been greater nor has the scope of the transformation been larger, and proceeding down an errant path with the wrong technology or the wrong partner could negatively impact customers, increase costs and reduce competitiveness.

However, by identifying and analyzing the top challenges, asking the right questions of potential solution partners and developing a phased migration approach, service providers can reduce their risk and enjoy the benefits of an agile network with increased service velocity, an expanded addressable market and improved profitability.

KEY FINDINGS

- SPs have 14 top challenges, which are identified and analyzed across the dimensions of business, technical, operational and organizational
- For the SP's launch of competitive SD-WAN and/or Enterprise vCPE services, corresponding solution attributes are identified that address those 14 top challenges
- SPs can increase revenue and profitability by automating and orchestrating their Dynamic Enterprise Services, which increases service velocity and the ability to sell and fulfill additional virtual services

Introduction

SD-WAN and Enterprise vCPE deployments involve abstracting functions previously performed with purpose-built hardware products such as routers or firewalls and instead implementing them as software functions running on general-purpose computing platforms of appropriate capacity and performance. A significant benefit of this deployment model is that functions can be deployed and operated more efficiently since they are loadable, configurable and upgradeable automatically under software control as virtual network functions (VNFs). The best Dynamic Enterprise Services solutions can be run on premises, in the data center or in a hybrid deployment model.

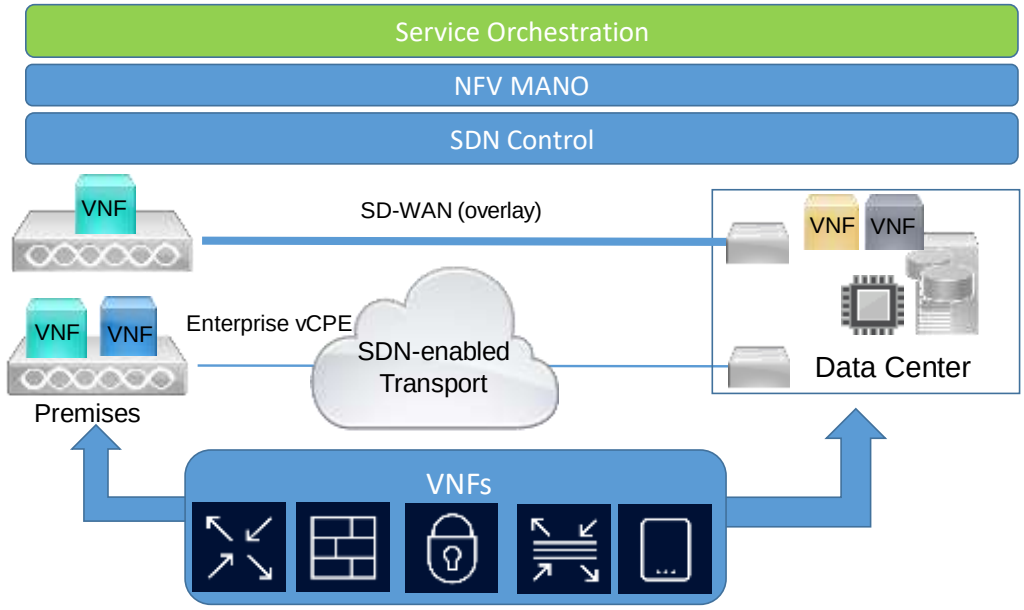

Figure 1. Generalized SD-WAN and Enterprise vCPE Deployment

Challenges for Service Providers

As service providers move toward mass commercial deployment of SD-WAN and Enterprise vCPE solutions, they face many challenges and concerns. In ACG Research's work with service providers, we have determined that these challenges can be placed into one of four broad categories: business, technical, operational and organizational. Given software defined networking (SDN) and NFV technologies are relatively new and rapidly evolving for use in service providers' networks, much attention has been paid to the technical challenges and to ensure that these solutions actually work. However, to move beyond trials and POCs, service providers need to consider all four categories when architecting their solution and selecting partners and suppliers. The top 14 challenges of service providers are listed in Table 1 followed by a brief explanation of each.

Challenges/Opportunities	Primary Functional Category
1. Increasing revenue & ARPU	Business
2. Controlling operational costs	Business
3. Expanding total addressable market	Business
4. Accelerating service velocity	Business
5. Customizability of solution	Technical

6. Adaptability of solution	Technical
7. Simplicity of solution	Technical
8. Flexibility of deployment options	Technical
9. Scalability of solution	Operational
10. Service management and assurance	Operational
11. Legacy OSS/BSS integration	Operational
12. Skills of teammates	Organizational
13. Organizational silos	Organizational
14. Product silos	Organizational

Table 1. Top 14 Challenges for Mass Deployment of Dynamic Enterprise Services

Increasing revenue and average revenue per user (ARPU). In a 2016 sample of 48 service providers, ACG Research found that one of their major concerns was revenue stagnation. Most services have flat to declining revenue on ARPU. Mobile data is the one exception, but even with mobile data, bandwidth demands and costs are outpacing revenue growth.

Controlling operational costs. In the same survey, we also found that escalating operational costs are eating profitability. There are multiple reasons for increasing operational costs, including complex and siloed product deployments.

Expanding total addressable market. In order to increase revenue, service providers would like Dynamic Enterprise Services to reach more customers. There are two dimensions to expanding the addressable market. One is the ability for the service to reach customers outside the traditional service area. Another is the ability for the service to reach more customers within the existing service area. For Dynamic Enterprise Services this means a solution that can be deployed outside of the traditional service area while also being deployable in the existing service area across the broadest number of customers from extra-large enterprises to small-medium businesses (SMB).

Accelerating service velocity. Service providers have been frustrated by the number and pace of new service introductions and deployments they have been able to achieve with their present mode of operation. Because services have been hardware-centric and product siloed, it can take months and even years to test and launch a new service. Service providers want to deploy more services faster and so do their customers.

Customizability of solution. To achieve the reach and scale desired, service providers need to be able to tailor the service for individual customers. Examples include modifying security settings or quality of service parameters from default values.

Adaptability of the solution. An adaptable solution is one that can be modified and enhanced over time. Dynamic Enterprise Services need to be able to add new services or modify existing functions, including the ability to easily swap out or replace individual VNFs.

Simplicity of the solution. If operational costs are to be brought under control while also deploying Dynamic Enterprise Services at scale, then the solution must be simple. Software automation,

standardization, abstraction from details and open programmatic interfaces are some of the tools that are necessary to reduce solution complexity.

Flexibility of deployment options. With Enterprise vCPE and SD-WAN deployments, some service functions may need to be hosted on premises while other functions may be better suited to hosting inside the data center. There will also be cases where an existing vCPE hardware platform is already deployed at a branch office and the service functions need to be hosted on the existing hardware. Solutions that do not provide flexible premises, data center and hybrid deployment options, limit the addressable market and/or increase operational and capital costs for service providers as they work to provide a comprehensive solution.

Scalability of the solution. Just as with addressable market, there are multiple dimensions to scalability. One dimension is the ability to deploy 100s and 1,000s of services in a day. Another dimension is performance monitoring and service assurance for 1,000s and 10,000s of services and customers. In mass commercial deployment, the entire service life-cycle and not just service instantiation must operate at scale.

Service management and assurance. In order to meet service level agreements and customers' expectations, Dynamic Enterprise Services solutions must provide real-time monitoring and management. Key performance indicators must be available, collected, analyzed and presented to the service provider.

Legacy OSS/BSS integration. Network service providers are not deploying Dynamic Enterprise Services only in greenfield locations. Service providers have existing networks and services that will need to be migrated over time. The ability to integrate legacy OSS/BSS solutions with modern SDN control and service orchestration software is critical in achieving a cost-effective, phased migration.

Skills of teammates. SDN/NFV networks demand new skills and capabilities from the service providers' workforce. Out are legacy protocols such as TL1 and SNMP and in are next-generation protocols, data models and open interfaces such as NETCONF, YANG, TOSCA and REST APIs. The skillsets of service providers' employees will need to be augmented and service providers will need partners with the professional services and training staff to support them.

Organizational silos. Service providers understand that just as the network needs to change to become more agile and programmatic to increase service velocity so does the organizational structure. Perpetuating existing silos among engineering, planning and customer service will not create the collaborative DevOps model with increased service velocity that new operator services require.

Product silos. In many cases, organizations are oriented around individual products or services. As an example, security services might be owned by one organization, while VPN or optical wavelength services are owned by another organization. Simply perpetuating such organizational product silos with an agile network will not aid in controlling operational costs or increasing service velocity. Service providers will need to evolve their organization structures to improve efficiency and create a shared learning environment with virtualized services running on common infrastructure.

Attributes of Solutions that Overcome the Top 14 Challenges

Industry leading SD-WAN and Enterprise vCPE solutions have attributes that can help service providers overcome these 14 challenges. We identify these attributes so service providers can consider them when selecting potential partners and suppliers. We also reference Nokia's products and approaches to reference tangible examples of how to address the challenges with a well-known supplier's offerings.

Versatile and Robust Network Software and Infrastructure

We begin the analysis at the customer premises. Flexible deployment options that include VNF hosting on the vCPE hardware, at the data center or in a hybrid approach ensure optimal service delivery. Multiple vCPE hardware variants including ones with compute and storage to support on-premises VNF hosting as well as CPE units that only provide physical demarcation, performance statistics and secure transmission help ensure that services can be provided cost effectively. Service providers will also encounter instances where enterprises have existing x.86 hardware at the branch office and want to deploy new services on the existing hardware. Support for third-party servers and deployment options that include bare metal servers, multiple hypervisors and containers keeps costs down and flexibility up. The ability to provide SD-WAN solutions as a complete network overlay or Enterprise vCPE as part of a comprehensive managed service also helps service providers reach the most customers, maximizing the addressable market and revenue.

Nokia's Dynamic Enterprise Services solution enables agile branch connectivity and managed network services, which provide service providers with opportunities for revenue growth. Service providers can choose between centralized and customer premises-based deployment options.

The services can be deployed to the enterprise as a SD-WAN network overlay with the **Nuage Networks Virtualized Network Services (VNS)** solution. An integral part of the VNS solution is the **Nuage Networks Virtual Services Platform** (**VSP**), which includes a centralized policy engine and an SDN controller to automatically establish connectivity between applications and the enterprise branch office along with service chaining of VNFs (Nokia or third party) included in the service. The SDN controller provides centralized control employing key elements of the same SR-OS operating system as the **Nokia Virtualized Service Router (VSR)** and its physical sibling, the 7750 Service Router (SR). By using programmable business logic and a powerful policy engine, VSP abstracts networking details, automates service creation and simplifies the overall solution.

Unlike SD-WAN deployments that are independent from the underlying network, Enterprise vCPE solutions are deployed in concert with the underlying network. In deploying Enterprise vCPE solutions, service providers need a broader set of networking equipment than an overlaid SD-WAN solution. Service providers need optical and routing infrastructure. The more consistency and collaboration among the network elements, the simpler the solution, the easier to deploy and the lower the operational expense. Embracing flexibility, Nokia supports both physical and virtual routing elements**. Nokia's VSR** is also based on SR-OS, matches the feature set of its physical platform sibling, 7750 SR, and has been architected and optimized to run on x86-64-bit computing environments. Nokia's 7750 SR and VSR support multi-tenant CPE virtualization and can be deployed in a service provider's central office or data center with the Nuage VSP supporting chaining of VNFs. By utilizing the SR-OS across VNS/VSP, VSR

and physical routers, Nokia simplifies the solution and reduces employee training and operational expense.

The IP/optical network beyond the end-points also needs abstraction, automation and intelligent control. Nokia's **Network Services Platform (NSP)** abstracts the programmable IP/optical network to deliver service automation and network optimization in an integrated, carrier SDN platform. NSP simplifies (reduces complexity) the network towards the OSS, works with both physical and virtual network infrastructure as well as infrastructure from multiple network vendors. As seen in Figure 2, NSP and VSP are complementary and can be utilized together to extend service chaining and network automation from the enterprise, through the WAN and to the data center.

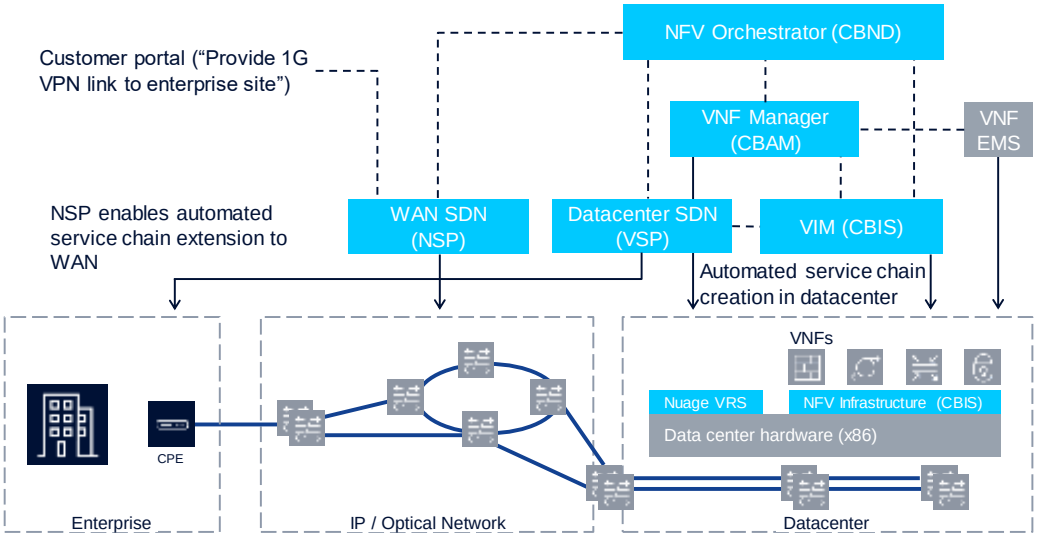

Figure 2. NSP & VSP Service Collaboration

Management and Orchestration

The ETSI NFV ISG has defined a three-part software model for deploying and managing virtual services. The Virtual Infrastructure Manager (VIM) accesses and allocates compute, storage and networking resources. VNF Manger (VNFM) manages the onboarding and life-cycle of each particular VNF. Finally, Network Functions Virtualization Orchestration (NFVO) actually retains a model of the network service and orchestrates the on-boarding of the VNFs and manages the services by establishing, cataloging and managing the resources required for the chain of VNFs that create an enterprise service.

Nokia's CloudBand software provides automated on-boarding of services and full ETSI MANO support. The modular flexible design of CloudBand enables customers to purchase one of three major components or an all-in-one bundle. CloudBand Infrastructure Software (CBIS) is OpenStack aligned and provides NFV infrastructure (NFVI) and VIM support. Certified NFVI hardware includes HPE, Dell and Nokia's AirFrame. CloudBand Application Manager (CBAM) is a VNFM that automates lifecycle management. CloudBand Network Director (CBND) provides orchestration of network services and resources for the NFV infrastructure under its control. CBND manages virtual resources across distributed geographies including at the enterprise or in one of many data centers.

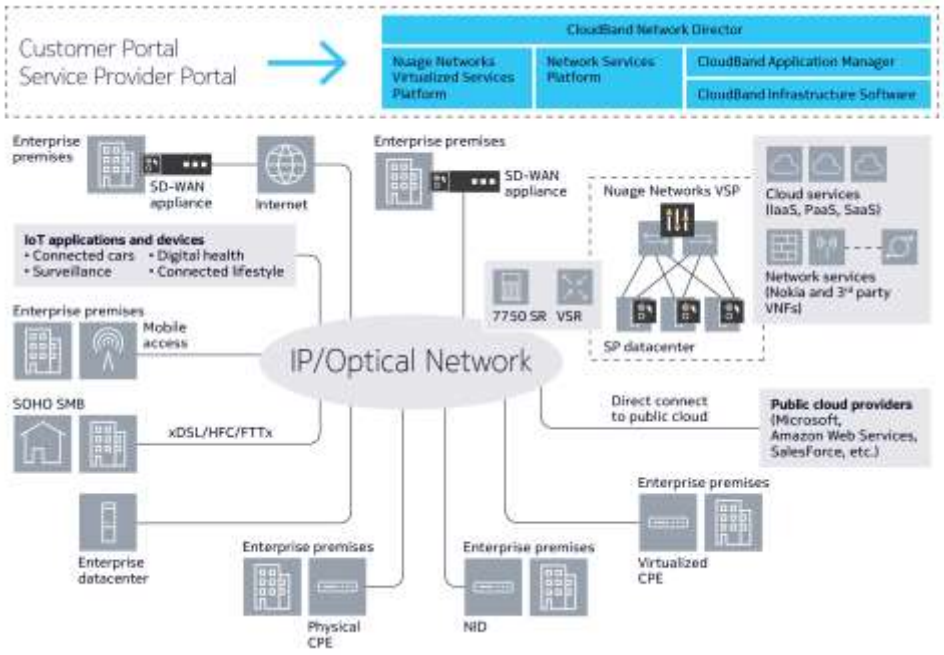

Figure 3. Enterprise vCPE and SD-WAN with VSP, NSP and CloudBand

The Dynamic Enterprise Services solution is referenced in **Figure 3**. Nokia's broad, modular approach enables service providers to mix and match the parts of the solution they need with their existing infrastructure and other suppliers.

Enterprise Self-Management

Enterprises want the ability to self-manage and monitor their services. They do not want to spend time on the telephone to add a new branch site, request additional bandwidth or enable security or communication services for a new employee. Enterprises also do not want to wait days or weeks for service delivery. Enterprises expect automation, rapid service delivery and self-help. One of the best ways to provide self-management is through a customer portal. Such a portal must be configurable by the enterprise and provide convenient dashboard metrics and controls. Nuage Networks provides a self-service portal with centralized policy control, a configurable dashboard with easy to read gauges and a configuration framework where existing services can be modified or new ones requested.

Open Source Foundations and Open Supplier Ecosystem

Open source community participation and open supplier ecosystems help ensure interoperability across suppliers, reduce development time and avoid vendor lock-in. Third-party partnerships for VNF also broaden a vendor's solution and ensure a "best-of-breed" mentality versus internally developed virtual functions. As a prominent example of this open-minded approach, Nokia is an active participant and contributor to multiple open source initiatives: OpenStack, OPNFV, Open Compute Platform, Telecom Infra Project, Open Networking Foundation and Docker. In addition, Nokia has an extensive third-party partner program with integration and certification labs in multiple geographies where VNF suppliers are encouraged to collaborate and become part of the solution.

Third-Party VNF Support

Proactive support for a third-party VNF ecosystem is critical to service providers' success with NFV. No one partner or supplier has every capability either now or into the future. By insisting on well-defined

and mature third-party integration and VNF onboarding, service providers can avoid vendor lock-in, enable a best-of-breed mindset and create an adaptable, extensible framework for the future. Nokia's CloudBand Ecosystem Partner program actively collaborates with third-party VNF suppliers. The program was created in 2013 and now has more than 60 members. Membership provides access to the Nokia's Cloud Innovation Center (CIC) where infrastructure and software are readily available for test and integration by its members. Preintegration and a well-defined on-boarding process maximizes solution flexibility and minimizes operational costs.

Deploying and Managing Dynamic Enterprise Services at Scale

There is no substitute for experience. Having a partner that has been there before can make all the difference in avoiding pitfalls and overcoming the challenges that do occur in the transformation to SDN/NFV enabled networks. It is that deep experience with real-world deployments that puts Nokia in a position to have the products, processes and tools to deliver commercially viable solutions at scale. Complementing its broad product portfolio, Nokia's professional services organization has developed a comprehensive approach to deploying Dynamic Enterprise Services through service provider engagements and real-world deployments.

Real World Expertise with SDN, MANO & Third-Party VNF Support

One of Nuage's earliest customers, MyRepublic, an Asian operator, has been deploying SD-WAN services in Singapore, Indonesia, Australia and New Zealand since 2014.

In North America, CenturyLink selected Nuage in 4Q-2015 as part of its Programmable Services Backbone (PSB). CenturyLink is on a mission to modernize and virtualize its enterprise and SMB services with the goal of having full virtualization coverage in its IP core network and data centers by 2018. CenturyLink was an early NFV adopter with the deployment of virtual firewalls and virtual content distribution networks. In a nod toward open ecosystems and vendor interoperability, the CenturyLink PSB involves numerous partners including Nuage. The VIM and MANO functions are provided by other parties.

In September 2016, UK-based Exponential-e, a cloud connectivity, business Internet and unified communications and IT services provider, announced the selection of Nuage Networks Virtualized Network Services as the basis for SD-WAN to automate provisioning and configuration of remote VPN locations. Exponential-e was challenged with connecting remote, off-net sites to its MPLS backbone. Depending upon the customer and the remote location, Exponential-e can now use Nuage for remote site connectivity as an overlaid SD-WAN or as part of a broader managed Enterprise vCPE service.

Nokia has also earned numerous service provider trials and deployments for its NSP solution providing service automation and network optimization for its customers. In late 2015, Nokia and TIM, Telecom Italia's unified brand, announced that NSP would be deployed in combination with IP and optical infrastructure to define new services and activate them in real-time. In September 2016, Jiangsu Telecom, a regional branch of China Telecom, announced deployment of the NSP along with Nokia's XRS core routers. The NSP's network optimization capabilities will be used to steer traffic and optimize resource loading in real time for the inter-data-center core network.

CloudBand has more than 30 commercial references and live deployments. One example of a real-world learning from customer engagements is the realization that not all third-party VNF providers deliver comprehensive VNF managers with their solution. In addition, ETSI is still evolving its specifications for VNF templates to include appropriate life-cycle management attributes. Without such descriptions, VNFs tend to be static, manual and lifeless. To facilitate consistent third-party VNF on-boarding and interoperability with full life-cycle support, the CloudBand team created a generic VNFM (ref: ETSI GS NFV MAN-001, Section 5.4.2) for use by third-party VNF suppliers and Nokia's own VNFs. CBAM has VNF templates that help to automate resource allocation and cover the full life-cycle of the VNF from instantiation to termination and in between. As an open collaborator, Nokia is also feeding its VNF templates back into the appropriate ETSI NFV working groups, as well as supporting them in a manner that they can be used by NFV infrastructure management systems using OpenStack HEAT templates, Ansible Playbooks or TOSCA NFV data models for orchestrating operations.

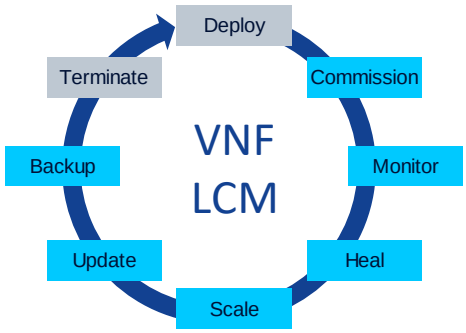

Figure 4. VNFM and Full VNF Life-Cycle Management

Reduce Risk with a Phased Deployment Plan

Service providers are facing four broad categories of challenges and risks in their digital transformation: business, technical, operational and organizational. One of the best ways to improve the probability of success is to eliminate entire risk categories where possible. By launching SD-WAN and Enterprise vCPE solutions for enterprise customers first, service providers can reduce their risk and improve their probability of successful SDN/NFV transformation. Modern IP/MPLS, Enterprise VPN and security services are well established and have been deployed profitably by service providers for years. By deploying a known, established set of enterprise services with a virtualized implementation, service providers virtually eliminate business risk in many ways. Service providers also minimize their operational and organizational risks. SD-WAN and Enterprise vCPE deployments can be converted or installed one enterprise customer at a time, and with modest training and support, existing deployment and customer service organizations can learn to deploy and manage the services effectively. The main risk for SD-WAN and Enterprise vCPE deployments then becomes technological, which is also something that can be managed with good practices, integration and partners.

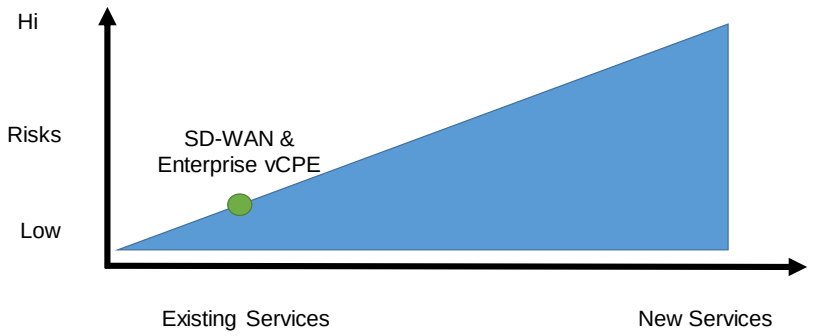

Figure 5. Service Provider Risk Profile

Defined VNF On-Boarding Boarding Process

With its Cloud Innovation Center and CloudBand Ecosystem Partner program, Nokia has developed a formal test and integration approach for on-boarding VNFs and applications to its solution offerings. Nokia has developed a five-level (L0-L4) Application Maturity Model (AMM) to describe the level of test, integration and automation that has been performed. A Level 0 solution is manually deployable and contains virtually no automation; a Level 4 solution is fully automated across all aspects of the life-cycle including deployment, fault-recovery, scaling and in-service upgrades. Having consistent language about the maturity of a solution and its level of integration eliminates confusion and provides a high degree of transparency for service providers.

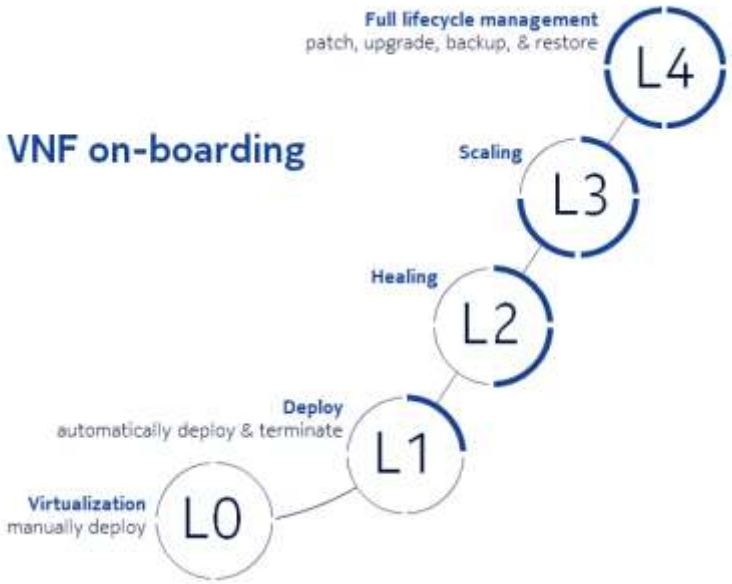

Figure 6. Formal VNF On-Boarding Process

Cloud Verification Toolset and Methodology

Experience has shown that all clouds and all networks are not created equal. More than 80% of the time, Nokia encounters service providers' SDN/NFV deployments where a portion of the cloud infrastructure the service provider wants to use already exists. This means that in the vast majority of cases, network deployments are not greenfield. Pieces of the solution are already in place and must be tested for interoperability and validated against performance expectations.

Nokia developed tools including **CLO**ud **VER**ification (CLOVER) for just this purpose. CLOVER is both a tool and a methodology to support Nokia's cloud validation and verification process. The methodology is born of experience and is an automated approach to assessing the readiness of a cloud infrastructure for specific VNF deployments.

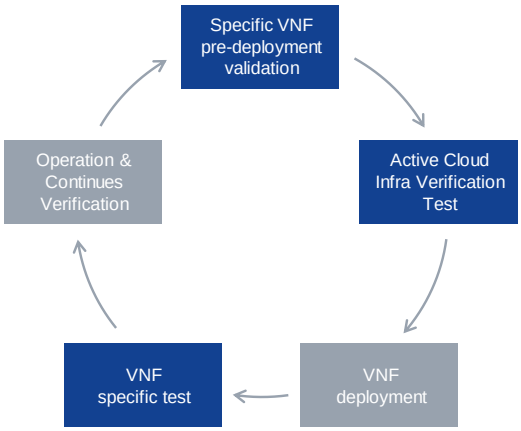

Figure 7. Formal Cloud Verification

The process as outlined in **Figure 7** begins with pre-deployment validation. In this phase, the VNF is tested in a reference cloud under various networking conditions to ensure proper life-cycle behavior and establish a performance baseline. In parallel, this phase uses the CLOVER software tool to assess the readiness of the target (also called active) cloud infrastructure (NFVI) that will support the VNF. CLOVER checks things such as the version of OpenStack, the type of hypervisors and the availability of storage and compute resources. The goal is to identify any issues with the cloud infrastructure prior to VNF deployment. Actions can be taken to remediate issues before deployment. Identifying and resolving issues before deployment saves time, reduces operational expenses and prevents customer pain. The VNF is then loaded onto the target NFVI. Additional VNF specific tests are executed to validate that the VNF is running as expected in the live target environment. During this test phase, any variations or anomalies against the performance baseline are investigated. In the final phase, the VNF goes live with service provider traffic, and the service is handed over to operations where it is managed throughout its lifecycle.

Service Assurance Evolution

The introduction of Dynamic Enterprise Services creates new service assurance challenges for service providers, including the need to aggregate information across the wide area network and NFV domains for services that by their very nature are continuously changing (for example, dynamic). In order for SD-WAN and Enterprise vCPE to be deployable at scale, service providers need automated data collection, correlation and analysis for both physical underlay and virtual overlay resources. Data is needed across the full breadth of the service chain, including numerous network elements and VNFs in multiple geographies. Without automated, comprehensive service assurance, service providers will not be able to measure and manage the actual enterprise experience in real time and in a cost-effective manner.

Even traditional IP/MPLS, Ethernet and optical enterprise services with mature service assurance capabilities must evolve. As SDN enablement makes these services more dynamic and consumption-based, SDN enablement also makes the network demands and traffic patterns less predictable. Solution providers must be able to extend monitoring, supervision and fault management to a new multi-vendor

SDN framework. The assurance process must also be fully automated to avoid increasing manual workload and operational costs. As one example, the Nokia NSP product uses SDN and centralized control policies to automatically adjust bandwidth or steer flows when user-defined latency or congestion thresholds are exceeded.

Network-as-a-Service (NaaS)

For service providers that need to migrate to Dynamic Enterprise Services with SD-WAN or Enterprise vCPE deployments but currently lack the skills, resources or time, NaaS is an option. With NaaS, a partner such as Nokia can deliver a full turn-key solution from design through deployment and service fulfillment. Under the best arrangements, the partner works collaboratively to transfer knowledge to service providers' personnel. The partner runs the solution until it can transition responsibility for the network and services back to the service provider as resources, knowledge and skills dictate.

Effective Knowledge Transfer and Training

One of the keys to scaling Dynamic Enterprise Services is ensuring that service providers' employees have the proper SDN/NFV related knowledge and skills they need. As part of AT&T's Domain 2.0 program, AT&T created Workforce 2020, a program to identify the skills and create the blueprint for acquiring them. Since 2013, AT&T has spent more than $250 million on employee education and professional development[1]. Although each service provider will have its own program for retraining its workforce and acquiring SDN/NFV skills, working with a solution partner that can skillfully transfer knowledge and train on specific aspects of the solution will also be critical to achieving mass commercial deployment. Nokia has a global training organization with SDN/NFV skills and has developed an extensive set of courses for on-line and on-site delivery. In addition, all courses can be taught in a "train the trainer" format to help the service provider become self-reliant with increased flexibility in its training delivery programs.

Experienced Professional Services Personnel as Extensions of the Service Provider

The best professional services organizations have extensive SDN/NFV knowledge and experience and can operate as an extension of the service provider's team. Nokia has 1,000s of professional services personnel deployed across the globe. It's development, test and integration organizations have been working with agile and DevOPS methodologies for years. Nokia's professionals can share their experiences and best practices in breaking down organizational and product silos and organizing for Dynamic Enterprise Service delivery as well as the broader SDN/NFV digital transformation.

Conclusion

In order to adapt to changing customer expectations and increasing competition from a new generation of cloud and content-based service providers, network service providers are evolving their static, purpose-built networks into dynamic, agile ones based upon SDN and NFV technologies and launching Dynamic Enterprise Services via SD-WAN and vCPE deployment options. In doing so, service providers are encountering and need to address 14 challenges to successfully deliver their services.

Nokia's Dynamic Enterprise Services solution demonstrates many positive attributes that service providers are seeking. The comprehensive end-to-end solution delivers hardware and software from the

[1] AT&T's Talent Overhaul, John Donovan and Cathy Benko, October 2016.

customer premises through to the data center. Flexible deployment options including SD-WAN overlay and vCPE managed service increase revenue by expanding the addressable market beyond the current service provider footprint. Nokia's focus on automation aids simplicity while enabling enterprise self-help, service assurance and minimizing operational costs. An open, collaborative ecosystem with a mature VNF on-boarding process and custom tools expands the solution breadth and ensures future adaptability. A global professional services organization with real world SDN/NFV deployment experience ensures that service providers have a collaborative partner that can solve real technical challenges but also support broad service provider transformational objectives such as breaking down product and organizational silos.

Although service providers have reason to be concerned about the numerous business, technical, operational and organizational challenges associated with the mass commercial deployment of Dynamic Enterprise Services, by enumerating these challenges, asking difficult questions of potential partners and identifying desirable solution attributes, service providers can overcome their challenges and successfully transform their static, hardware-centric network into an agile, dynamic one with increased service velocity and profitability.

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Authorship: This paper was authored by ACG Research which is solely responsible for its contents.

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Appendix A: Definitions

SD-WAN: Software-defined WAN is the deployment of virtualized enterprise services as an overlay to the underlying physical network. Industry leading SD-WAN solutions are highly automated and operate independent of the underlying physical connectivity which may be provided by MPLS, DSL, DOCSIS, Ethernet or Wireless. A centralized SD-WAN controller is used to automate provisioning and service activation and to simplify connecting the devices and branch offices of an enterprise. Since the solution is a network overlay, SD-WAN solutions may be sold to the enterprise by a network service provider, an alternative service provider or by the SD-WAN vendor themselves.

Enterprise vCPE: Like SD-WAN, Enterprise vCPE is also about virtualizing Dynamic Enterprise Services in a move toward virtualized software functions versus siloed delivery with on-premises, custom hardware per service. The main difference with SD-WAN is that Enterprise vCPE solutions are not agnostic to the underlying physical network. Enterprise vCPE solutions are sold by a network service provider as part of a broader managed service where the underlying physical connectivity is often part of the offer.