Building Networks as Agile as the Cloud

Executive Summary

Harnessing the Intelligence of Nokia's Network Services Platform for Multilayer, Multivendor Service Provider Network Services

Advances in communication and cloud computing technologies have at a remarkable rate immensely improved peoples' quality of life and the effectiveness of businesses in every sector. Innovations in application and endpoint device capabilities regularly open up opportunities for productivity and achievement. These advances are occurring in large measure because of the visionary adoption of architectural frameworks that accelerate the delivery of solutions enabling the gains.

Although these advances have been occurring steadily in domains such as smart phones and cloud computing data centers, they have been slow to arrive in service providers' (SP) networks that serve to connect people with each other and the applications they want. Large-scale SP networks at every level—from metro and regional to national and international—have lagged the pace of innovation in agility that has been achieved in the other domains by a four- to five-year span. Consequently, the routing, switching and optical infrastructures supporting the growing population of endpoints and computing systems have not been able to become full partners in the pace of innovation for which the world is looking.

That is all about to change.

KEY FINDINGS

- In the past two to three years we have experienced a surge in creative efforts and developments producing the components needed for SPs' networks to become as agile and efficient as the cloud applications they support.
- Nokia has been an active participant in this evolution and with its introduction of the Network Services Platform (NSP) is taking a position at the leading edge of the SPs' transformation process toward becoming more agile engines of innovation.
- NSP delivers a unique blend of capabilities to service providers to help them realize their agility and innovation goals.

Introduction

In the past two to three years we have experienced a surge in creative efforts and developments producing the components needed for networks to become as agile and efficient as the cloud applications they support. These have been occurring under the broad umbrellas of software-defined networking (SDN), network functions virtualization (NFV), and service orchestration. Focus has been on abstracting and simplifying the development and delivery of multiple types of network services spanning multiple layers of technology and a wide range of deployment domains.

Operators have confirmed their commitment to embracing these solutions in recent architectural road mapping projects, in deeper engagements with suppliers on addressing the most critical problems, and in early deployments of platforms and applications designed to streamline operations, optimize deployments, and accelerate service differentiation and delivery.

In our analysis of service providers' plans for deploying multilayer SDN solutions, we projected uptake for those solutions across multiple domains and layers of technology, including metro, IP edge and core/backbone networks. We gauged that the pace of deployment for SDN across these three domains will have a compound average growth rate of 133 percent during the period leading to 2018. These deployments will occur in a combination of solutions that include path optimization and service level agreement control, as well as simplified multivendor, multilayer provisioning, and automation. Solutions will contribute efficiencies in operational and capital expenses, as well as in accelerated time to revenue for new service offerings. In all, these solutions will generate SDN software revenues to service providers in excess of $3 billion annually toward the end of the forecasting period. While initial phases of adopting SDN have been concentrated in data center deployments, use of SDN software in service provider IP/optical networks will pick up pace as operators validate solutions and apply them to transition their networks into agile service delivery platforms.

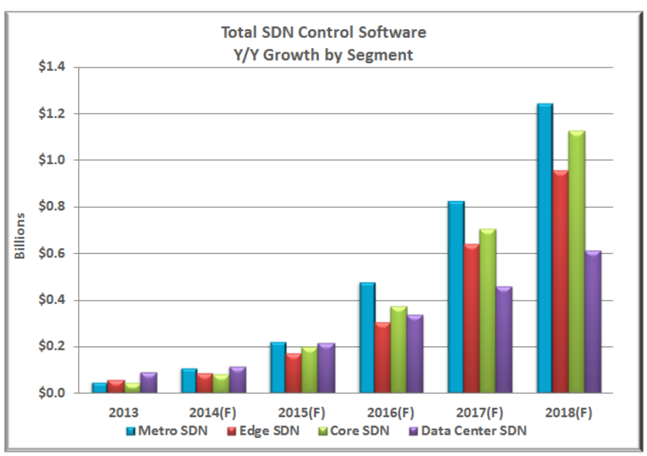

Figure1. Uptake of SDN Solutions in SP WANs, 2013-2018

Clearly, the level of interest in applying SDN principles to the operator WAN is high, as is the desire to make the most impactful gains possible at each step in the process.

This vision of streamlining and innovation is being applied to “all four points” of the network compass (north, south, east, and west) and is concentrated on simplifying the service creation and life-cycle management processes. Agility on these four dimensions is illustrated in the Figure 1, which shows where development and innovation are occurring to enable service velocity and reduce the size of the gaps that exist between the connected spheres.

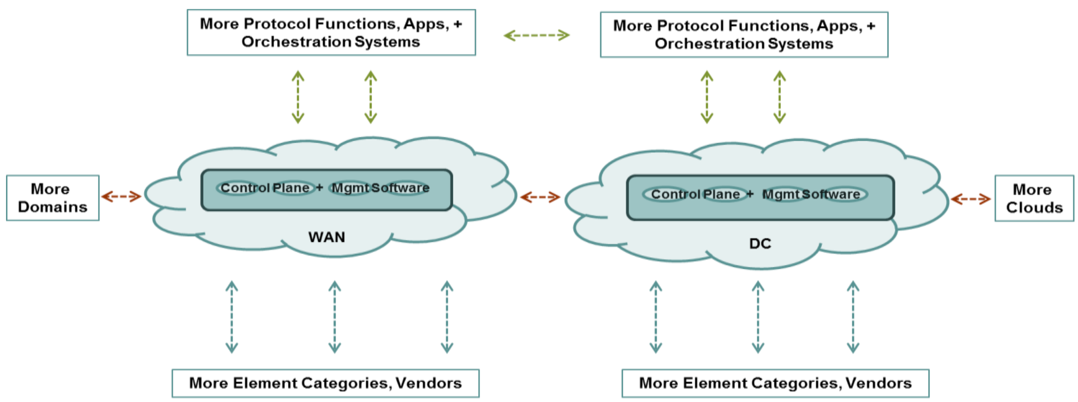

Figure 2. Directions of Innovation in SDN

Enter the Network Services Platform

Nokia has been a leader in this SDN/NFV evolution, and with its introduction of the Network Services Platform (NSP), is taking a position at the leading edge of the SPs’ transformation process toward becoming more agile engines of innovation.

Nokia’s NSP delivers a unique blend of capabilities to service providers to help them realize their agility and innovation goals in their wide area networks. It contains logic honed over the course of 1000s of network deployments with operators in each key layer of wide area network deployment (Layer 0/1 optical transport and Layer 2/3 packet network services specifically). It benefits from the ongoing research at Bell Labs into ways wide area network operations can be improved. It employs a number of architectural building blocks essential to achieving the versatility, efficiency, and openness in service delivery so critical to operators as well as performing a vibrant role in their value chains.

NSP is composed of two powerful subsystems that work in unison to provide streamlined service creation, provisioning and real-time, intelligent network controls. These are called the Network Services Director (NSD) and the Network Resource Controller (NRC), respectively. NSP also maintains a rich multi-layer network model that NSD and NRC share and that provides information to them on topology, state, capacity, and utilization. A common mediation engine is available to NSP subsystems so that they can communicate with the multivendor, multilayer, multidomain networks NSP they are managing.

The general alignment of NSD and NRC in NSP is shown in Figure 2.

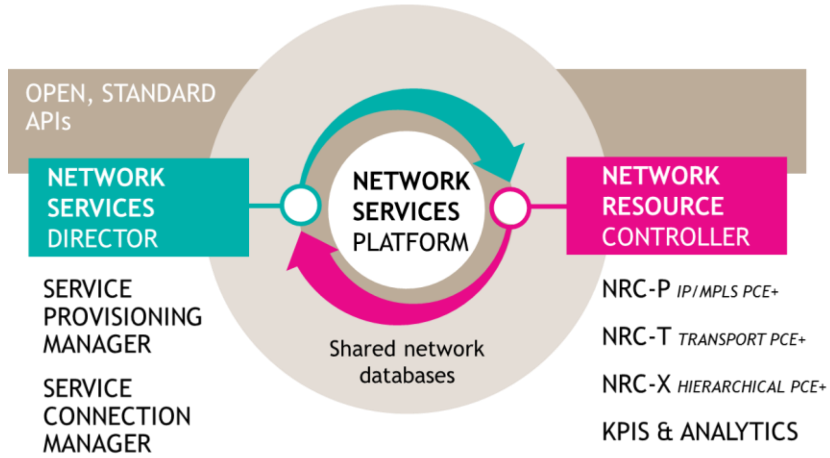

Figure 3. NSP Including the NSD and NRC Subsystems

Streamlining Service Creation

NSP greatly simplifies the relationship of OSS and BSS applications to the networks on which they are working and in the process dramatically reduces the time required to define and introduce a new network service, as well as the resources required to do so. Historically, service creation in SPs' WANs has been a fragmented, arduous, and time-consuming process. Because network infrastructures comprise purpose-built, proprietary, closed system platforms and there has been no consistently abstracted way of conveying the nature of the SPs' service goals to them, the tasks of defining, billing for, provisioning and operating the underlying infrastructures have been silo'd, redundant, costly, and inefficient to scale. In most significant service initiatives, elapsed time to deliver a working result in the field for an operator has averaged 18 months.

NSP eliminates this tangle of semantics by leveraging simpler, model-based descriptions of services and their underlying networks using the versatile, standardized, and increasingly important YANG data modeling framework. In addition, it opens up access to these abstractions using REST based application programming interfaces, making communication with OSS and BSS applications flexible and efficient. In this way NSP streamlines the task of defining and activating new service offerings. In an analysis we conducted as part of the introduction of NSP we determined that, for example, new offerings of bandwidth calendaring and bandwidth on-demand services, a representative operator stands to realize an efficiency gain of at least 50 percent in the OSS and IT tasks involved in readying the new service for market compared with present modes of operation.

NSP provides additional value via a policy management function it incorporates that allows an operator's service delivery policies to be associated with the abstract descriptions of the services it defines. The policies are applied to the network first via intelligent provisioning and then via real-time monitoring and controls as operations proceed. Policies about delay, cost, capacity, and other parameters are associated with the underlying network and communicated to target nodes using NETCONF/YANG and other semantics depending on the network element. Binding policies to services and resources in this manner allows NSP to help the operator differentiate and meet its service level agreement objectives for flexibly and at scale. The operator does not need other solutions to determine that resources are available or to identify stitching points when creating composite connections. NSP will do that based on its knowledge of the network topology and the services being deployed.

Now, although NSP is able to streamline service creation and provisioning for the network, how does it perform the ongoing path optimization and real-time network controls that extend its benefits to improved network and operations efficiencies and increased revenue generation?

This is where the NRC comes in.

Intelligence and Automation in Network Control

NRC is an intelligent engine for real-time policy-based control and optimization of the network and its services. It uses the common software layer shared with the NSD to discover the topology of the network through a variety of data sources, and it maintains an active view of the state of the network through ongoing data collection and evaluation. NRC employs the policies that have been created for the network through its interaction with the NSD and the platform's support for use of common policy attributes throughout its operation.

NRC uses a versatile combination of standards-based protocols for communicating with the range of network elements it is managing. These include the Path Computation Element Protocol (PCEP), NETCONF, and BGP-LS. It also includes a set of functions that draw on Nokia's broad experience in live operator networks enhanced with Bell Labs' investigations of communication technologies and how they can be improved. These include monitoring of key performance indicators (KPIs) that trigger adjustments so that operators can meet their service delivery and network efficiency goals. They also include functionality from Bell Labs' self-tuned adaptive routing algorithms that help optimize IP/MPLS and segment routed paths based on real-time network link utilization data.

The general structure of the NRC is illustrated in Figure 3.

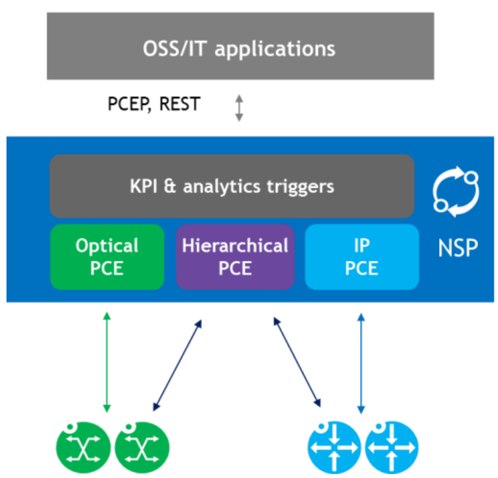

Figure 4. NRC Structure

One reason NRC is able to do its job so well is the modular design it uses to support multiple layers of network operation concurrently. This is instantiated on one level by using three distinct versions of path computation engine (PCE), named PCE-T, PCE-P and PCE-X, respectively, for optical (T), IP/MPLS (P) and multilayer and multidomain path optimization, where optical and packet resources are optimized at the same time (X). The PCEs derive significant functionality and design advantage from experience Nokia has in prior optical deployments using its 1830 Photonic Services Switching System and its GMPLS control plane in conjunction with Nokia's Service Aware Manager (SAM) and Optical Management System (OMS). They also benefit from IP/MPLS networks where Nokia's Service Router Operating System (SR OS) has been used.

Another way NRC reflects its heritage in large-scale deployments is its readiness to apply the policies it has incorporated into its monitoring and decision-making processes to the network it is managing *in real time*. There is a great advantage in making allocation and optimization decisions in real time versus needing to wait until the right consensus among different fragmented tools and teams has been achieved (sometimes requiring days). *Now* is the time dimension on which users and subscribers increasingly expect their requests to be fulfilled, and being able to meet those expectations will provide a great advantage to the operator. Having a service-aware, policy-aware, multilayer, multivendor "brain" available in real time to make exactly the right decisions that a variety of subscribers and applications require to meet their goals is precisely the advantage operators are seeking from their deployment of SDN.

A concrete example of how policy awareness, real-time monitoring and real-time optimization come together in support of an operator's service is how an operator might make real-time adjustments in resource allocations to support a bandwidth on-demand offering. An operator's policies for such a service in a given subscriber's case might entail the assurance of a given amount of bandwidth or delay to be enforced for the entire length of the subscriber's purchase. For this guarantee the subscriber might be willing to pay a premium. At the time of ordering the service, NSP might observe that the only way to meet the criteria would be to adjust the path of some other deployments that do not have any of the same sensitivities to another route, freeing up the resources to allow the on-demand subscriber's request, as shown in Figure 4.

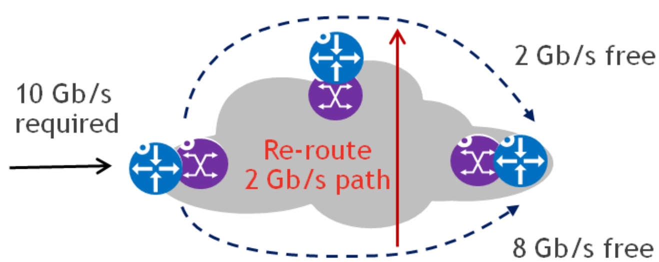

Figure 5. Path Adjustment

By making these adjustments in real time the operator can gain more efficient use of its network and earn greater revenues at the same time. Having the intelligence to determine the state of the network, to make the adjustments needed to meet the request, and to activate the required resources—all on demand—is a result of this unified approach to SDN.

Expanded Benefits with Portfolio "Reach"

The value of NSP to the operator can be enhanced by considering its use in tandem with other solutions from Nokia that optimize operations in adjacent domains.

One example of this is in the synergies available between cloud computing data centers and the service-aware networks of the WAN that NSP controls. Nokia's Nuage Networks solutions for virtualized networking in data center and remote enterprise sites can be combined with the NSP to make the automation of services in an end-to-end offering nearly a button-push operation. An example of how this might be applied to dynamic management of an integrated cloud computing and VPN service for business subscribers is shown in Figure 5 below.

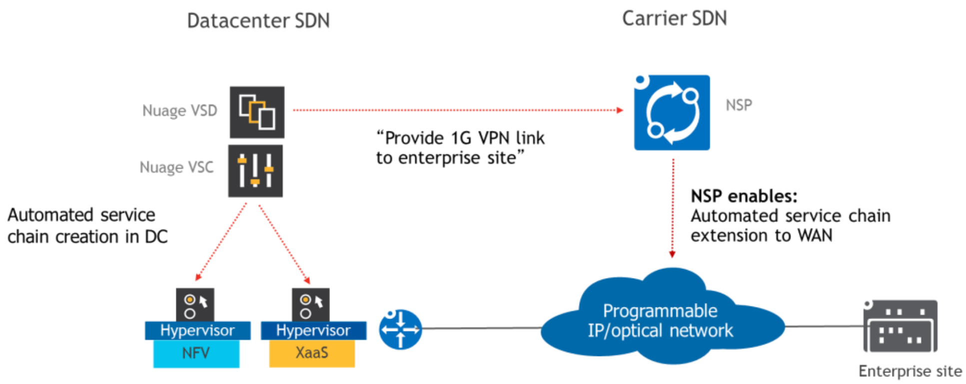

Figure 6. NSP and Nuage Coordinated Operations

Another example of larger synergies achievable with NSP is using it in support of virtualized network functions so crucial to the realization of elastic services in the cloud. An operator could employ Nokia's Cloudband Management System (purpose built for NFV) in tandem with NSP for its underlying WAN along with Nuage for datacenter networking to create solutions for residential, mobile, and enterprise services. NSP's service templates help it integrate cleanly with a VNF orchestration system such as Cloudband and support dynamic creation of service chains for VNFs in the network it is managing, automatically and at scale.

A final example of the whole being greater than the sum of its parts for NSP is its alignment from a "whole service delivery" point of view with Nokia's Motive suite of service management applications, perhaps best highlighted by the Motive Dynamic Operations (MDO) application suite. NSP takes advantage of abstract definitions of network services to streamline MDO operations; MDO employs a similar approach in creating its own repository of abstractly described end-to-end services and in using an open-standards-based approach to coordinate the management and deployment of those services with collaborating connectivity management platforms such as NSP. Use of REST based APIs and its own adaptor (or mediation) layer gives it the openness required to evolve as new services and domains come into play.

Unlocking Agility and Innovation

In creating NSP Nokia has applied its vision and considerable expertise to eliminating the two most significant communications roadblocks service providers have been wrestling with to have their networks behave with the agility of the cloud. Northbound, NSP's use of open APIs, standardized data modeling, and templates for service definition functions makes a dramatic contribution to eliminating the cumbersome, costly, and repetitive OSS and BSS processes that have slowed down new service introductions in the past. Southbound, NSP's support of IP/MPLS and optical network layers across multiple network domains and multiple vendors' platforms greatly streamlines the management of the network, and it turns the network into a service delivery platform. By adding a powerful array of KPI monitoring and policy enforcement functions to its real-time analysis of the operation of the network, NSP helps the operator optimize the network to support offered services and accelerate the pace at which new services can be deployed.

By blending these advanced functions into a unified solution, Nokia is making a significant contribution to the state of the art in wide area networking and SDN. NSP's combination of streamlined service creation and versatile, highly automated provisioning and control provide a unique opportunity for operators to turn their networks into truly agile service delivery platforms. In this process NSP can make a significant contribution to narrowing the gap between aspiration and achievement as operators strive to bring their own innovations to their customers and the cloud.