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NEC's SDN for the Service Driven Network

A Frost & Sullivan White Paper

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INTRODUCTION

Carriers are experiencing an increasingly challenging environment in which they have to continuously scale their networks (in order to meet rapidly growing traffic) while having to settle for declining revenues. The disconnect between exponential traffic increase and logarithmic revenue growth has become more exacerbated over the last three years, due to a host of factors including the proliferation of smartphones, the uptake of video, and the increased penetration of mobile broadband.

Figure 1: Revenue / Traffic Disconnect

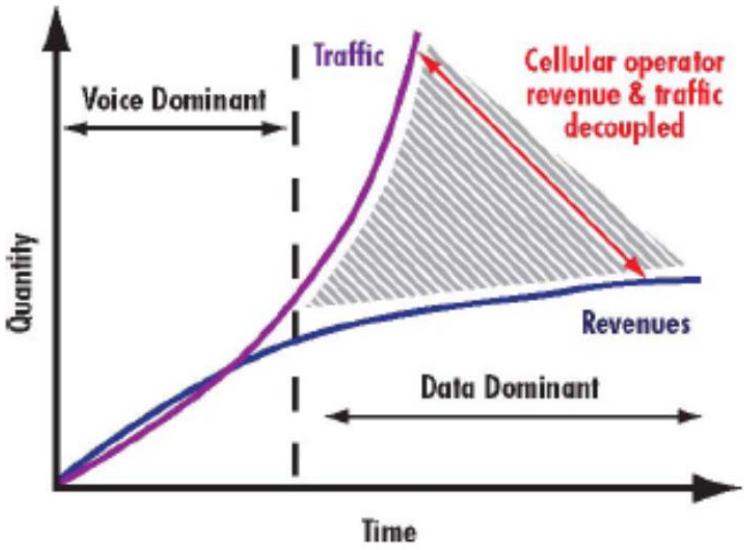

Figure Source: Broadband Forum

"Program services instead of re-architecting the network and the management system for every new service" - Peter Löthberg, IETF Executive Director and Swedish Internet guru.

Furthermore, operators are facing intense competitive pressure from Over-The-Top players such as Apple, Google, Skype and others, which are nimbler and can deliver new services in a quicker fashion. Lastly, another major carrier pain point is the increasing cost and complexity of managing its network, loaded with many vertical "stovepipe" services.

Clearly, newer solutions need to be considered and replace the legacy implementations which are no longer sustainable over the long run. Two new technologies that have gained a lot of attention from the operators over the past couple of years are SDN (Software Defined Networking) and NFV (Network Function Virtualization).

In this White Paper, we will examine SDN and NFV from a carrier's perspective. The starting point will be the current state of the industry, the evolution towards an SDN carrier network and the benefits incurred by operators as they transition to an SDN/NFV solution.

Then, we will examine NEC's SDN/NFV value proposition, how the company is addressing the key carrier requirements, and examine a key reference deployment. Finally, we will conclude with our impressions of why we believe NEC is uniquely positioned to be a trusted and reliable SDN/NFV partner.

SDN Defined

SDN can be thought of as a novel approach to networking enabling carriers to achieve a more efficient control of their infrastructure, drawing upon customization and optimization to deliver innovative network services. SDN allows a controller (server based software) to determine how packets are forwarded by networking elements, separating the control and data planes within switches/routers This approach makes networks more "programmable" by abstracting network elements and exposing them to various apps. There are 3 key features in the SDN architecture:

- Separation of the control plane from the data plane
- A centralized controller and view of the network
- Programmability of the network by external applications

This is depicted in the figure below:

Figure 2: SDN Architecture

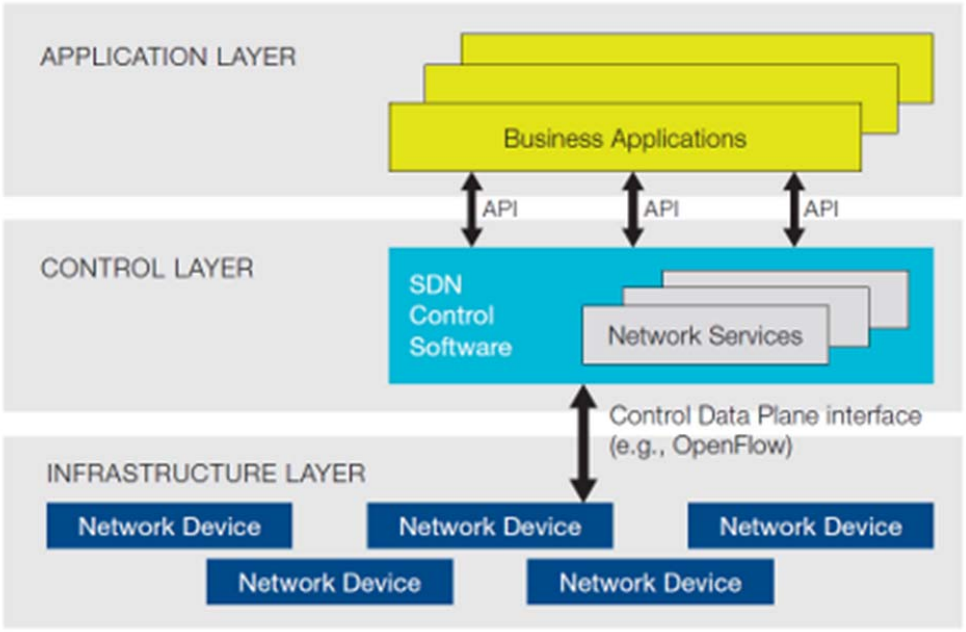

Figure Source: ONF

The key element in the architecture is the centralized SDN controller, which can be thought of as the software that is responsible for making policy decisions within the network. The controller has the system functions necessary to control the physical and virtualized network, in addition to network function resources, bypassing conventional L2/L3 protocols.

The control plane data interface between the SDN controller and physical or virtual network devices (the "Southbound API") is well defined by the OpenFlow specification, which has industry-wide support (i.e., vendors and operators). The "Northbound APIs" are vendor-specific and represent the programming interfaces between the applications and SDN controller.

The advent of SDN represents yet another instance of the ongoing "ITfication" of the telecom Industry, with IT models being used to usher the next stage of networking industry development. SDN can represent the industrial revolution of networking, driving the same scalability and standardization that was made possible by factories from the mid-1700s forward, as they replaced hand production.

The notion of separating the control and data planes via a more horizontal architecture certainly does not represent a novel idea in the telecom industry, having been done before in frameworks such as IP Multimedia Subsystems (IMS), a 3GPP specification for delivering IP multimedia services. But what is different about this concept this time around? Are the probabilities of success higher now? We believe so, based on the fact that SDN has two other pillars to stand on: openness and NFV.

Figure 3: SDN, NFV and Openness

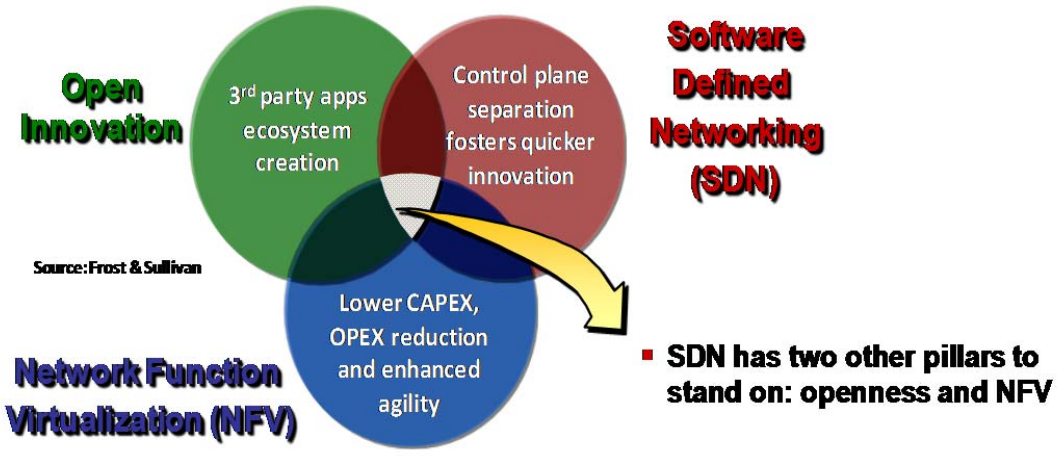

Figure Source: Frost & Sullivan

NFV and SDN are closely related, mutually beneficial but not necessarily inter-dependent: NFV can be deployed without SDN and vice-versa. The technologies really meet different goals.

SDN can improve NFV performance by easing operations and simplifying compatibility. It can also allow virtualized network functions to be sewn up together into service chains. NFV enhances SDN via virtualization, IT orchestration and management techniques. Simply put, SDN represents a network evolution whereas NFV is a platform advancement.

NFV was born out of a need to meet service provider needs such as lowering CAPEX by eliminating proprietary hardware, and consolidating various network functions onto industry-standard platforms. Another even bigger NFV benefit is OPEX reduction, with the move from a network equipment to a datacenter deployment architecture. ETSI's NFV Industry Specification Group (ISG) manages the NFV specs.

SDN comes from the IT world, bringing about the separation of the data and control plane, while centralizing the control. SDN delivers the ability to program network behavior via well-defined interfaces. The ONF (Open Networking Foundation) is responsible for the advancement and standardization of OpenFlow, the dominant SDN protocol framework at this time.

The Combined Benefits of SDN/NFV

There are a host of benefits that SDN can deliver, including, among others:

- Efficiency: optimization of existing applications, services, infrastructure and management/operations, resulting in CAPEX and OPEX savings.
- Scalability: enabling an operator to rapidly grow an existing application or a new service in a modular, economical fashion.
- Programmability: allowing the fast provisioning of new services; the time to provision new services is the top network challenge according to most operators.
- Service awareness: another by-product of the programmability aspect, delivering operators features such as guaranteed QoS and on-demand "express traffic lanes".
- Service exposure (via APIs): new revenue generation opportunity for operators, which can deliver new applications and business models.
- Elastic capacity: leveraging the performance growth of industry standard high volume servers
- Improved OA&M: simplified operations moving from a network element to a datacenter deployment model
- Virtualized architecture: bringing benefits in scalability, energy, footprint and resiliency options

EVOLVING TOWARDS AN SDN/NFV CARRIER NETWORK

As already discussed in the introduction, carriers are faced with exponential traffic growth brought upon by factors such as a bigger mobile broadband penetration (globally expected to surpass the 20% mark in early 2014), larger adoption of smartphones (which consume on average at least twice the data traffic of a feature phone) and the higher usage of data intensive applications such as video (video traffic expected to grow at over a 65 percent CAGR from 2012-2017 according to various industry sources). The increased traffic load requires not only a higher capacity but also more connectivity and capacity in the network.

Concomitantly, social responsibilities such as green initiatives geared towards reducing power consumption, data security/privacy, public safety and disaster recovery are becoming an integral part of both enterprise and operator stakeholders' agendas.

SDN and NFV can be technologies capable of addressing all these areas. The SDN/NFV value proposition is premised upon the following three pillars:

1. Infrastructure (SDN) – virtualized, programmable, scalable & highly reliable networks, delivering CAPEX reduction

2. Management & Orchestration – automated, comprehensive and flexible configuration coupled with centralized control and management, entailing a lower OPEX

3. Services (Open APIs) – new revenue generation potential via differentiated services, service agility (improved service velocity), and simpler service provisioning. New services could be uniquely enabled by the SDN architecture, or could be enabled by the open API to 3rd party solution developers. This is a key differentiator among vendors

For an operator willing to embrace SDN/NFV, it will first have to evaluate a valid business case where the technology can bring value. After that, the carrier will have to work with a trusted partner vendor to design a proof-of-concept project. Subsequently, it will have to take the lessons learned and apply them for a full-blown project which can take place when vendor products become more mature.

INTRODUCING NEC'S SDN AND NFV SOLUTIONS

NEC SDN/NFV Architecture

The NEC SDN architecture consists of the following elements:

- SDN controller: NEC is an SDN pioneer, having launched the world's first commercial OpenFlow Controller and Switch range in 2011. The Controller can be deployed as a cluster, with hot standby for seamless failover. NEC's OpenFlow product range is branded as ProgrammableFlow.

- SDN data plane: The ProgrammableFlow switch range supports large OpenFlow tables in TCAM for line-rate processing. The switches are hybrids and also support conventional L2/L3 protocols for interconnect with installed network infrastructure. For transport networks, optical and packet layers will be converged and managed by the centralized SDN controller, as one network with OpenFlow interfaces. Hence, the core and edge router functions can be abstracted to the SDN Controller, lowering Layer 3 dependency and allowing router off-loading. This will lead to reduction of router hardware in the network infrastructure.
- Virtualized functions: NEC is aggressively developing NFV functionalities on top of a common and open hardware and software infrastructure. NEC's carrier-grade hypervisor enables the virtualization of network functions on Commercial Off-The-Shelf (COTS) hardware platforms. The company's NFV solutions are fully interworking with legacy systems. NEC's participation in the ETSI NFV Industry Specification Group (ISG) is consistent with its goal to offer highly reliable and cost efficient virtualized network functionality on industry standard servers. The first two focus areas in this direction are mobile core and network edge functionality.
- Hypervisor – Softswitch Interoperability: NEC has productized an OpenFlow-based virtual Switch for Windows Server HyperV. HyperV is increasingly being evaluated by carriers globally. The advantage of the Windows Server HyperV softswitch is that it gets control of the traffic as early as possible in the server. The traffic goes through the same softswitch if it is on the same hypervisor. Out of the four major hypervisors available in the marketplace today, three (Hyper-V, XEN, and KVM) have options for built-in OpenFlow support within NEC's product portfolio.
- Management & orchestration: For the cloud datacenter, NEC has both a commercially available offering and an Open Source solution (with OpenStack). For the carrier network (including NFV), the company leverages its NetCracker suite. NEC's NetCracker OSS/BSS solution can be leveraged for the operation and management of customer assets and inventory, as well as the billing function. This solution can also ensure QoS can be maintained by performing fault detection and analysis, as well as monitoring resource shortages. NetCracker interworks with both legacy networks and SDN, thereby ensuring a smooth transition from legacy to SDN. The SDN Controller's orchestration function interworks with NetCracker to manage network and server resources for the coordinated control of the end-to-end infrastructure.

NEC'S SDN Positioning

NEC's SDN positioning is supportive of the following:

- Open network infrastructure (ProgrammableFlow) – NEC not only was the first vendor behind OpenFlow but also constantly participates in innumerous interoperability and bake-off industry events, including EANTC's Multi-Vendor Interoperability Event - 2013.

- Work with third-parties to develop application ecosystem – NEC partners with best-in-class vendors across areas such as management (including Real Status), security (including Radware and vArmour Networks), and optimization (including A10 Networks and Citrix for load balancing and SilverPeak for WAN Optimization).

- Driving standardization of Northbound interfaces in ONF – NEC remains highly committed to helping drive standardization of these interfaces within the ONF, to enable a common SDN framework for support of services including anti-DoS, follow-me cloud, instant VPN/TE, SDN-based mobile backhaul, SDN-based service chaining, and IPv6 transition via SDN.

- Contributing to Open Source community – NEC is a gold member of Project Open Daylight, an open-source project spearheaded by vendors in order to accelerate SDN adoption under the auspices of the Linux Foundation. Towards that goal, NEC has contributed with its Virtual Tenant Network (VTN).

- R&D collaboration with leading Tier-1 carriers: NEC collaborates with a host of carriers including NTT Communications (SDN/NFV), Telefonica (SDN/NFV) and Portugal Telecom (evaluation of network virtualization based on SDN technology for datacenters and carrier networks).).

NEC'S SDN Pedigree

NEC's SDN pedigree is second to none, being a pioneer and among early mindshare leaders. The company has a long SDN history going back to Clean Slate Program (Jan. 2008), and the introduction of the first commercial Open Flow products (switch and controller in 2011).

We believe that NEC is uniquely positioned to address network virtualization, which can be thought of as a combination of SDN and NFV. Once IP edge elements are software-based, network hardware can be managed as a pool of resources for software-defined functions. NFV delivers software-defined functions with high and predictable performance in addition to a homogeneous orchestration of compute domain. SDN allows the interconnecting of the virtual machines (VMs), or the backplane. This enables data encapsulation, and an easy orchestration together with compute domain.

NEC SDN/NFV Use Cases

NEC has been delivering SDN/NFV solutions to enterprise networks, data centers (private/public cloud and carrier), and service providers. The commercial SDN solutions that NEC has been delivering to-date include:

- networks for public and private cloud DCs, for carriers, service providers and enterprises
- campus networks for enterprises

NEC Deployment

NEC already counts with many reference sites. In this section we look at NTT Communications' Enterprise Cloud. Japan's leading global carrier has deployed NEC's ProgrammableFlow solution to deliver its Enterprise Cloud Service.

NTT Communications' Enterprise Cloud Service offers global cloud resources that enterprise customers can leverage through straightforward control and management. The enterprise customers can optimize their ICT costs while managing and expanding their global corporate footprint.

A global network of virtualized servers with virtualized network links within and among the data centers has been implemented, with NEC's ProgrammableFlow being deployed in the data centers. Its future framework is the global network of datacenters that could effectively function as a de-facto single virtualized data center for scalable and seamless services.

The end result was the simplification of configuration changes, which became flexible and on-demand instead of requiring cumbersome setup and configuration procedures.

Figure 4: NTT Com's Enterprise Cloud utilizing SDN

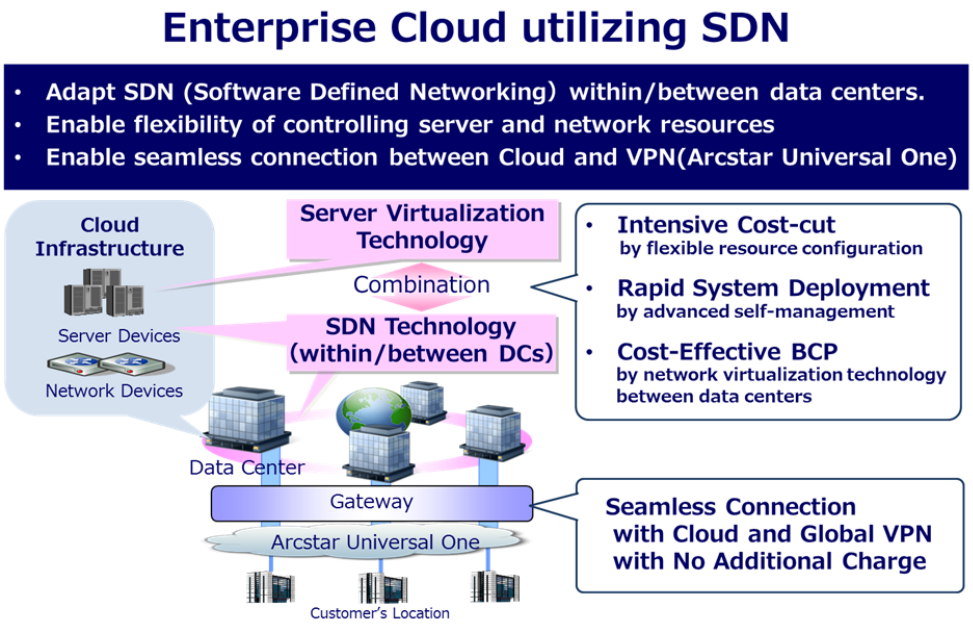

Figure Source: NTT Communications http://www.ntt.com/enterprise_cloud_e/

NTT Communications expects great CAPEX and OPEX reductions with innumerous benefits including improved monitoring and troubleshooting. These values are consistent with NEC's own estimates and serve as an important proof point of the lower CAPEX and OPEX that SDN can deliver.

CONCLUSIONS

As Geoffrey A. Moore eloquently points out in his best-seller "Crossing the Chasm", there is a gap between the early adopters of a new technology (the so-called "technology enthusiasts" and visionaries) and the early majority (the pragmatists). SDN and NFV are steadily getting closer to that point of adoption, in other words, to reaching the early majority that is mainly constituted by pragmatists. Until that point in time, however, certain best practices among thought leaders, visionaries and technology enthusiasts can be shared, in addition to the formulation of strategies to help address the key issues relevant to a particular carrier customer.

Throughout this exercise, carriers will need to rely on the expertise of advisors which already have gone through the experience, in order to maximize the benefits of both SDN and NFV. We believe that NEC is uniquely positioned to be a trusted SDN/NFV operator partner during the entire process, since it can leverage the following intangibles:

- Early mindshare in SDN: NEC played an active role in the creation of the OpenFlow specification, since the early stages of the Clean Slate program (January 2008). The vendor was a key participant in the early research and trials, building a prototype OpenFlow switch as early as August 2008. NEC also launched the world's first commercial OpenFlow Controller and Switch range back in 2011.
- Strong IT/systems integration excellence: IT expertise is a critical success factor for a successful SDN/NFV advisor, as IT methodologies are increasingly embraced by operators seeking to optimize their performance. NEC can deliver on both sides of the fence. The company has a long history of developing innovative solutions for the IT and Networks markets, having amassed a vast experience in areas such as computing technologies (server and storage), IP networks, optical transport and mission critical systems. In addition, NEC can also leverage its NetCracker OSS/BSS suite for interworking with legacy networks and SDN and accelerated service fulfillment to ensure a smooth transition to SDN.
- SDN expertise: NEC is behind some of the early SDN deployments both for enterprise and carrier customers, such as research and enterprise networks, carrier data centers, and data centers for private and public cloud. The customer pedigree includes the Japanese National Institute of Information and Communications Technology (NICT), the Kanazawa University Hospital, Nippon Express and NTT Communications.
- NFV acumen: NEC is playing a key role in the ETSI Network Function Virtualization (NFV) Industry Specification Group (ISG). The goal is to assist operators to embrace NFV, moving from "proof-of-concept" to real projects. NEC is initially focused on rolling out mobile core and network edge offerings running as virtualized functions on COTS servers. The NFV functions are being developed on top of a common and open Intel-based hardware and software infrastructure.

In summary, NEC's SDN/NFV portfolio is simple and flexible. "Simple" means offering a streamlined architecture and operations, which results in lower carrier OPEX. "Flexible" alludes to delivering network agility to respond to service change needs, which translates to an enhanced service velocity.

ABOUT THE AUTHOR:

Ronald Gruia is the Director for Emerging Telecoms at Frost & Sullivan, where he covers topics such as NGN transitional technologies, 4G/LTE, IMS (IP Multimedia Subsystems), FMC, VoIP, SDN (Software Defined Networking), NFV (Network Function Virtualization), Carrier Messaging/Value Added Services Platforms, IPTV, IP Centrex, Triple Play Services, Enterprise Communications Systems, Unified Communications, and Video Conferencing, among others. He has spoken at conferences such as Supercomm, VON, 3GSM, MWC, CTIA, Futurecom, VMA, TMIA, IMS Expo, IPComm, Fierce IPTV, Intel Communications Summit, VON Canada, IP World Canada and Comdex Canada.

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Mr. Gruia is an MIT graduate in Electrical Engineering, and has accumulated years of experience in the telecom industry, having held several roles at Nortel Networks' Enterprise Division, where he earned a U.S. patent.

This paper is part of the ongoing coverage of worldwide information and communications technologies markets by Frost & Sullivan (www.frost.com), an international growth consulting company. Working closely with our clients, we use advanced market research methods to identify and analyze the critical market challenges they must address to become successful competitors in their industry.