WHITEPAPER

Software Defined Networking (SDN)

Driving SDN Adoption in Service Provider Networks

This whitepaper provides an overview of key requirements and enablers for driving SDN adoption in Service Provider networks.

ON.LAB

INTRODUCTION

Service Providers are actively exploring Software Defined Networking (SDN) for successfully managing the challenges of traffic explosion, increasing the average revenue per user (ARPU) and lowering CapEx and OpEx. Benefits that software-defined networking (SDN) brings with the separation of the control plane from the data plane are widely known and accepted. SDN promises to make workloads (including network functions) elastic, distributed, and more efficient*. New services can become plug and play and instantly available. While SDN has made giant strides into Datacenters, its adoption is in very early stages in Service Provider networks. This whitepaper analyzes the key requirements and enablers for widespread adoption of SDN in Service Provider networks.

SERVICE PROVIDER NETWORKS ARE RIPE FOR TRANSFORMATION

With the proliferation of mobile devices, OTT services and distribution of content across the cloud, the growth of traffic in Service Provider networks continues to outpace revenue. Variability of traffic is increasing, with a much larger range between the largest and smallest flows, and the number of endpoints of varying capabilities and complexities continues to explode*. Service Providers want to make their networks agile and efficient to meet the challenges of these exponential bandwidth demands and be able to create revenue streams with innovative services and new business models.

Software Defined Networking (SDN) has emerged as the paradigm that has the potential to transform these networks by delivering cloud-style agility and innovation and reinstating economic viability. By 2020, SNS Research estimates that SDN and NFV can enable service providers (both wireline and wireless) to save up to $32 Billion in annual CapEx investments **.

Service Providers are eager to adopt SDN. AT&T introduced its revolutionary vision for the company's network of the future, titled the "User-Defined Network Cloud", supported by its Domain 2.0 supplier program. ATT aims to embrace SDN and NFV to improve the value of its network by driving improved time-to-revenue, providing cost- performance leadership, enabling new growth services and apps, ensuring world-class, industry leading security, performance and reliability, and facilitating new business and revenue models*.

However Service Provider networks are inherently more complex, in addition to being multilayer, serve a diversity of users and require high availability and performance. Compared to Datacenters, a more stringent set of requirements will need to be met to enable proliferation of SDN in these networks. This whitepaper describes the key requirements and enablers to drive widespread SDN adoption in Service Provider networks.

KEY REQUIREMENTS FOR ENABLING SERVICE PROVIDER TRANSFORMATION

Service Providers rely on rich, reliable and differentiated services to generate revenue and retain customers. However differentiated services are turning into commodities in record time thereby necessitating constant service innovation. Service providers are also looking to reduce CapEx and OpEx by taking advantage of the technology innovations in SDN, cloud computing, hardware, and open source, however their networks need a rethink to be able to do so. Driven by the need to seek lower cost avenues for their hyperscale Datacenters, Cloud providers were responsible for the rise of original design manufacturers (ODM). Similarly with the simplification of the dataplane with SDN, white boxes are becoming compelling, low-cost options for Service Provider networks.

** Source: AT&T and attinnovationspace.com* ***Source: http://www.snstelecom.com/the-sdn-nfv-network-virtualization-bible*

Service Providers state the following as being critical to the transformation of their networks:

- Operations-friendly Policy driven network programmability

  Service creation, instantiation and innovation velocity require that providers have the ability to provision applications in an agile and intuitive manner on a diversity of hardware. Service provider DevOps and operations teams want to be able to specify what they or their applications need in abstract high-level terms without worrying about how this will get instantiated on the underlying network.

- Cost-efficiency

  Providers not only want to extract maximum value from their existing networks but also to be well positioned to take advantage of network and device innovations, such as white boxes, that provide a variety of benefits such as lower costs, high performance and new functionality.

- Benefits of SDN without compromising reliability and performance

  SDN decouples the control plane from the data plane and centralizes it with well-understood benefits. However Service Provider networks place stringent requirements on this control plane in that it not only needs to provide benefits of SDN but should also be resilient and high performance. The SDN control plane should be able to scale to meet the growing size and demands of the network and customers.

- Shared-cost Technology Innovation

  Some of the SDN technologies, such as a robust control plane platform, are strategic and necessary part of SDN for Service Providers, but difficult to build and monetize. What can be monetized are the solutions built around this platform and the applications and services that thrive on it. Given the high stakes-low reward situation in developing these strategic SDN technologies, the challenge for Service Providers is to determine how to procure such platforms in a cost-effective manner without having to invest significant in-house resources. To address this challenge, Service Providers need a model where they can choose to develop strategic, technically challenging but difficult to monetize SDN control plane and similar platforms by teaming up and sharing the development cost with other organizations, to whom such platforms are also of value.

- Ease and self-defined pace of migration to SDN

  Migration to new paradigms is not a one-size-fits-all proposition. In case of SDN, Service providers want strategies that enable them to migrate existing networks to SDN at a pace that works for them. While Service providers want migration strategies to be progressive as opposed to disruptive in the short term, they also want these strategies to deterministically pave the path to SDN networks in a reasonable period of time without requiring an instant forklift upgrade and without a complete retooling of the SDN control plane at each intermediate and final step.

KEY ENABLERS OF SDN ADOPTION IN SERVICE PROVIDER NETWORKS

- Availability of a Carrier-grade SDN control plane

Service Providers want a carrier-grade SDN control plane for their networks, but building this is a complex undertaking. It involves solving difficult distributed systems problems to address the requirements of high availability, scale-out and performance. But that by itself is just the beginning. This control plane should be able to support a diversity of devices on the southbound and be able to accommodate the needs of Service provider use cases, application developers and operations groups on the northbound with simplicity of use and agility, but without compromising on the key attributes of high availability, performance and scale-out. This control plane should be extensible and modular to enable it to evolve with the needs of the Service Providers.

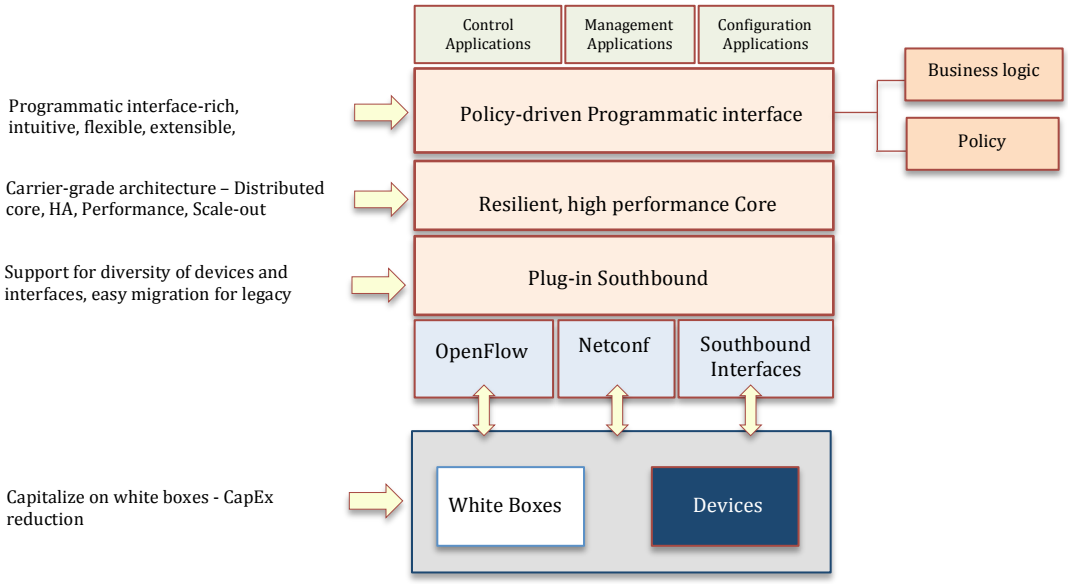


Figure 1. Carrier Grade Control Plane

- Rich, flexible, open abstractions and APIs on the Northbound and Southbound

Rich, flexible services that demand network programmability but in an intuitive, network-agnostic policy-driven manner are only possible by abstracting the physical infrastructure from control. This is the critical functionality provided by northbound abstractions and interfaces. The northbound abstraction should also be able to service and optimize across multi-layer networks, such as packet and optical, commonly a part of Service Provider networks. The southbound abstraction should encompass configuration, discovery, and programming of diverse devices through a variety of interfaces. Not only does this architecture provide modularity and portability of applications and allow diversity of devices, but also, with well-defined abstractions and interfaces, enables each of the system layers to evolve independently at its own pace of innovation.

- Network Functions Virtualization (NFV)

For Service Providers, Network Functions Virtualization (NFV) is, in many ways, the killer app of SDN. However NFV manifests in many forms and shapes, a rudimentary version being one where Service Providers are managing VMs with services in place of hardware devices that existed earlier. This could lead to Capex savings and some agility in provisioning, but not much operational efficiency. To exploit the full potential of NFV, what Service Providers need is the ability to manage services not servers. A "service" can be thought of as an abstraction that hides the complexity of orchestrating, provisioning, scaling and composing virtualized network functions (VNF) VMs.

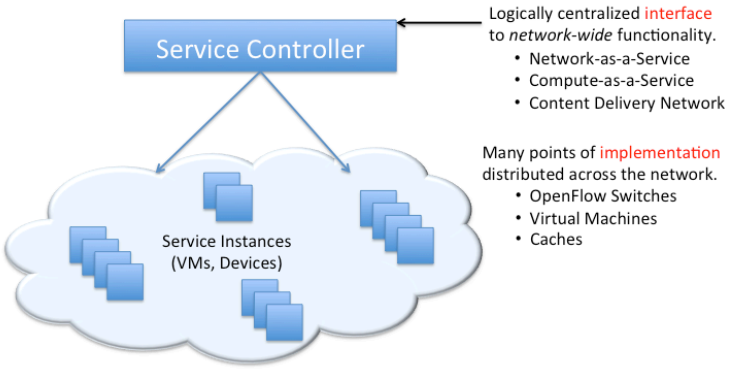


Figure 2. Anatomy of a Service

Service providers should be able to easily create new services by composing together two or more services. The services themselves should be such that they can be scaled up or down in response to provider needs.

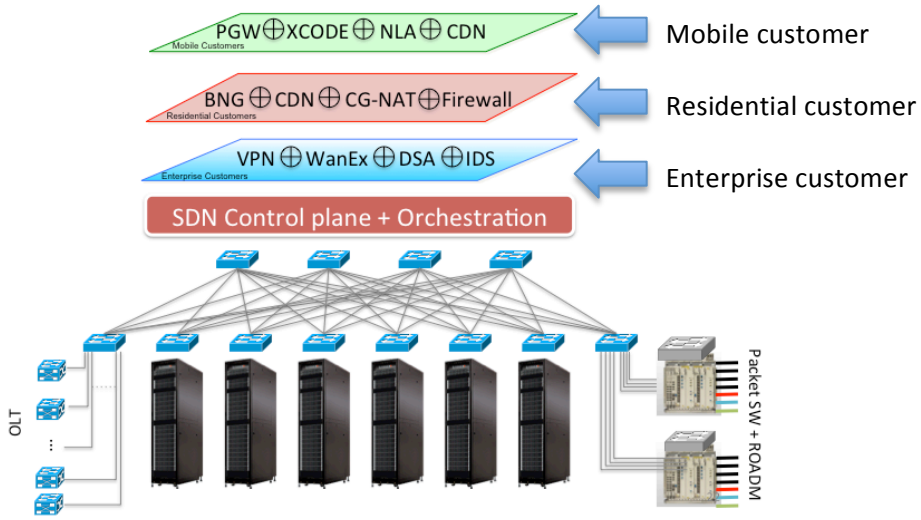


Figure 3. Service Composition

- Migration strategies that aid the transition to SDN in a reasonable period of time

  Some of the SDN approaches bring a level of provisioning and configuration control to existing Service Provider networks, but without truly extracting the control smarts from their devices. While this is easier, it also fails to move the Service Providers' existing networks to SDN networks in a reasonable period of time. Smarter strategies that continue to extract and move the control smarts from the devices onto the SDN control plane will be key to successful migration and to unlocking the full benefits of SDN.

- Emergence of Open Source as a viable Shared-cost technology innovation model

  Procuring strategic but hard to monetize SDN platforms by participating in and supporting open source projects building them is fast emerging as a viable model for Providers.

- Commercial grade solutions and support for Open Source SDN platforms

  Service Providers have been quick to realize the benefits of shared-cost technology innovation and have started supporting open source projects that are building SDN platforms. One of the key drivers for proliferation of such open source platforms and technologies in Service Provider networks will be the emergence of commercial-grade solutions and support services built on and around these open source platforms.

- Real world proof-points of SDN viability in Service Provider networks

  Trial and real world deployments of SDN in leading service provider networks such as those of AT&T and NTT communications, will serve to demonstrate the viability and value of SDN in solving real issues and bringing unparalleled agility, cost-benefits and innovation to these networks. Seeing SDN succeed in like environments will incentivize other service providers to push the envelope and usher the same benefits into their networks.

SERVICE PROVIDER SDN ADOPTION - KEY TAKEWAYS

- SDN is a paradigm that is of significant interest to Service Providers because it solves real issues they face in their networks.

- While almost every technology vendor has an SDN story and there are several open source projects that provide SDN solutions and SDN control platforms, each of these should be carefully vetted out with regards to features, abstractions, high availability, performance, cost, ease of migration, ease and availability of support as well as potential for extensibility and evolution.

- Given that SDN adoption is in early stages in Service Provider networks, a promising strategy is to include carrier-grade SDN platforms in smaller proof-of-concept trials but vet these platforms using metrics that will effectively gauge their viability for inclusion in real world Service Provider deployments.

- Service Provider network migration challenges are well understood in the SDN community. Well-architected SDN control platforms and solutions should include a transition path for brownfield deployments and support a diversity of devices and interfaces on the Southbound while also providing a clear path to the end goal of moving to SDN networks in a reasonable period of time.

- Providing commercial grade solutions and support around SDN open source platforms is a significant, relatively untapped opportunity for vendors.

- Open Source Carrier-grade SDN platforms, especially those built jointly with Server Providers and Vendors, are well positioned to be compelling options for Service Provider networks, especially when hardened and extended through feedback from Service Provider POCs and trial deployments and provided as commercial grade solutions with support by vendors.

- In the next 2-3 years, the biggest drivers for SDN adoption in Service Provider networks will be the Service Providers themselves. Successful SDN trial and deployment strategies and validation of SDN benefits by early adopters such as AT&T and NTT Communications will serve as blueprints for other providers and help drive the software-defined transformation of Service Provider networks.

DRIVING SDN ADOPTION – ON.Lab, SERVICE PROVIDERS AND VENDORS OPEN SOURCE ONOS

ONOS is a resilient high performance open source SDN network operating system purpose built for Service Provider networks. ONOS has been developed by ON.Lab along with a community of leading Service Providers, Vendors and Researchers and will be open sourced on Dec 5th, 2014.

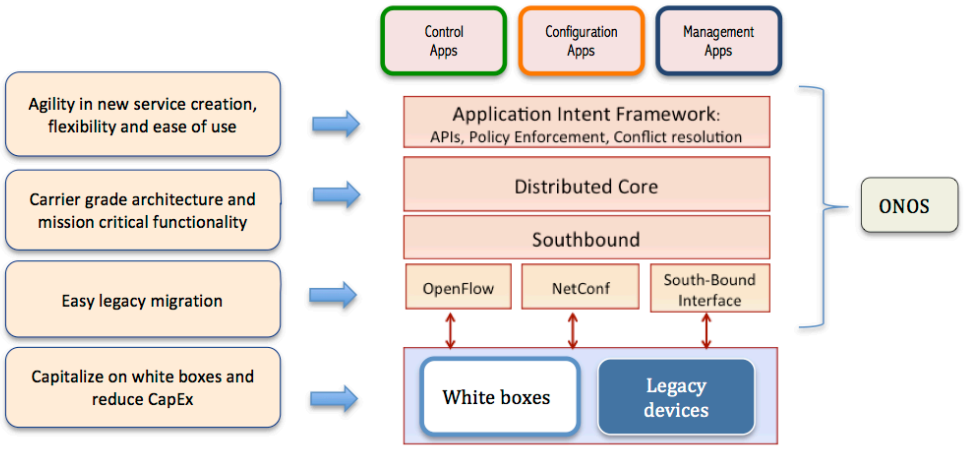


Figure 4. ONOS SDN Network Operating System

ONOS is multi-instance distributed SDN network operating system architected for high availability, performance, scale-out and well-defined northbound and southbound abstractions.

Key attributes that make ONOS well suited for Service Provider networks are:

- Northbound "Application Intent Framework": ONOS provides this policy driven programmatic framework to enable DevOps and operations groups to specify what they need without worrying about how this will get instantiated on the underlying network.

- Northbound: ONOS also provides the network graph with the view of the entire network as the northbound abstraction.

- Distributed core: provides high availability, high performance and scale-out

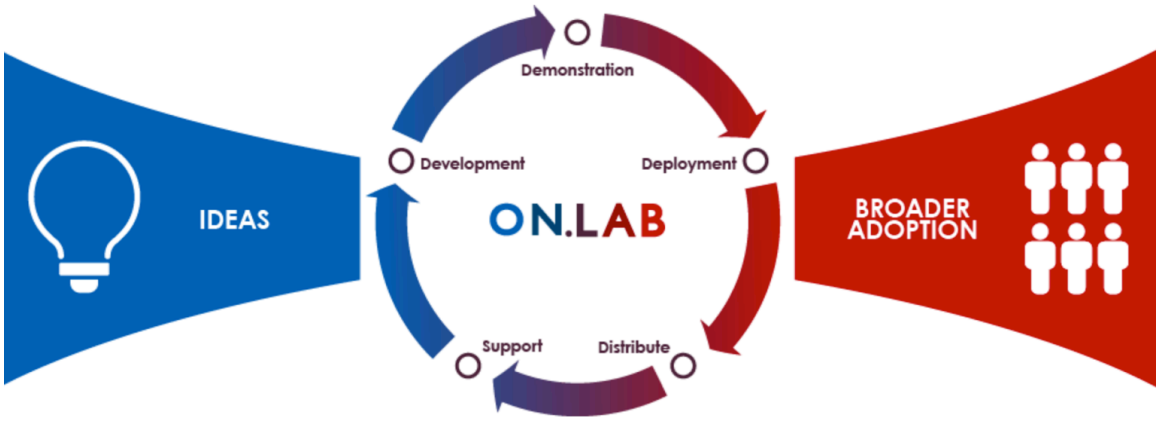
- Southbound: provides well-defined abstractions (for discovery, configuration and programmability) that enable ONOS to support OpenFlow and a diversity of interfaces and devices.

- ONOS Service Provider use cases: Multi-layer SDN control and optimization of packet-optical core, SDN-IP for seamless peering of SDN islands with the Internet, WAN-based control with segment routing, NFaaS- a scalable, flexible, intuitive take on NFV.

Open Sourcing ONOS on Dec 5th is the first step towards providing a carrier grade SDN control plane platform that the community can use, evolve, build on and drive. Join the mission to build a true carrier-grade network operating system -ONOS, at onosproject.org.

"Software-defined networking can radically reshape the wide area network. The introduction of ONOS provides another open source SDN option designed for service provider networks with the potential to deliver the performance, scale, availability and core features that we value."

John Donovan
Senior Executive Vice President
AT&T Technology & Operations



ABOUT ON.LAB

The Open Networking Lab (ON.Lab) is a non-profit organization founded by SDN inventors and leaders from Stanford University and UC Berkeley to foster an open source community for developing tools and platforms to realize the full potential of SDN. ON.Lab brings innovative ideas from leading edge research and delivers high quality open source platforms on which members of its ecosystem and the industry can build real products and solutions. ON.Lab has a team of highly motivated and talented individuals, with expertise and a stellar track record in industry and research institutions. ON.Lab's team is focused on creating high quality open source tools and platforms that benefit and bring true SDN value to the community.