THE CONSUMABLE NETWORK

PREPARING BUSINESS NETWORKS FOR THE CLOUD WITH SOFTWARE DEFINED NETWORKING

STRATEGIC WHITE PAPER

ABSTRACT

There is a large gap between business networks today and where they need to be to meet the on-demand connectivity requirements of cloud-based applications. Alcatel-Lucent aims to close this gap by using Software Defined Networking (SDN) solutions to transform the way companies build and use their networks, both in the datacenter and across WAN virtual private networks (VPNs).

Alcatel-Lucent SDN solutions will be based on a framework that automates network services and opens up the network for rapid consumption by applications. Through this framework, the network will be able to respond directly to application needs and automatically reconfigure itself in seconds. It will no longer rely on manual change requests and complex IT/OSS stacks, which slow down network service turn-up and stifle innovation.

The first Alcatel-Lucent SDN solution to be released, branded as Nuage Networks™, is initially targeted at datacenters. The Nuage Networks Virtualized Services Platform fully virtualizes and automates any network infrastructure, providing instant and unconstrained network service delivery for thousands of tenants.

But SDN innovation does not need to stop at the datacenter. The operational benefits of SDN solutions can be extended to the WAN with Software Defined VPNs (SDVPNs). This is a new kind of VPN that is optimized for cloud services, allowing businesses to connect their users and offices to the cloud instantaneously. They will be a complement to the traditional MPLS VPNs that connect most large companies today. Service providers can maintain high performance MPLS VPN connections at regional offices and datacenters, while instantly turning up new SDVPN connections at branches where the need for operational simplicity and cost effectiveness are more stringent.

In addition, SDVPNs are a much more responsive and cost-effective solution for enterprises that wish to continue to build their own do-it-yourself VPNs. SDVPNs rely on automated provisioning, dynamic connections, and open, inexpensive customer premises equipment.

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NETWORK CHALLENGES IN THE CLOUD ERA

When most people think of the cloud, they imagine consumers enjoying the benefits of public cloud services, or developers accessing shared server resources to rapidly develop new applications. Now, however, the revolution in virtualized compute and storage that spawned consumer clouds is shifting towards the enterprise and taking much of the networking industry's focus with it.

Virtually all enterprises have plans to leverage the agility, openness and economics of the cloud operating model. Many have virtualized servers and storage inside datacenters (DCs) that are spread across the globe, allowing them to rapidly move applications from one server to another when they need extra resources. New cloud-based IT services are transforming the economies of enterprise DC by providing on-demand capacity to cover shortfalls.

From the service provider (SP) perspective, growth in cloud services has been explosive. Leading enterprise cloud providers now boast access rates in the hundreds of thousands per second. Telecom SPs are also highly motivated – they are looking for ways to tap into this lucrative new cloud services market, and are investigating cloud-based architectures, such as network functions virtualization (NFV), to secure the benefits of cloud computing for their own applications.

While cloud growth spells opportunity for all, it is also placing a huge burden on today's enterprise and DC networks that were not designed for the cloud. There is a large gap between where networks are today, and where they need to be to fulfill the on-demand connectivity expectations of cloud-based applications and services.

DC networks are very cumbersome, restrictive and inefficient. The high-quality and multi-tenant scale of WAN VPNs are largely absent in today's DC environments. DCs are still running on basic VLANs and they do not scale or provide the required networking capabilities and performance to meet business application needs. In addition, the operational processes are highly manual and configuration driven. Network connectivity can take days or weeks to be turned up.

In the WAN, enterprises are typically connected using VPNs that provide secure, reliable and high-performance connections between their offices and DCs. MPLS VPNs are the "gold standard" for enterprise WANs and are ideal for larger companies with many people and computing resources that need permanent network connections. However, turning up secure MPLS VPN connections can take several weeks due to the complexity of equipment and the outdated processes and systems used to configure and manage the networks. Innovation to alleviate these problems has been stifled by the lack of agility, high complexity and closed nature of backend OSS/IT systems.

For the cloud to reach its full potential, today's network architectures — within the DC, between DCs and to the local office — must change.

The vision: SDN framework for business networks and services

Preparing today's enterprise or business service networks for the cloud is not a simple matter of adjusting feature lists or tweaking operational processes. Simplified, programmable network access and control is necessary to eliminate the need for manual intervention in the provisioning process, or to avoid the complexity of low-level IT/OSS integration. Operations must be simplified and service delivery automated to dramatically reduce operating expenditures and to be responsive to change.

How can this vision be realized? The solution is to break up today's monolithic network architecture and place the individual parts into a Software Defined Networking (SDN) framework. The SDN framework will assure that each part is more flexible, open and responsive to networking needs. This new framework must:

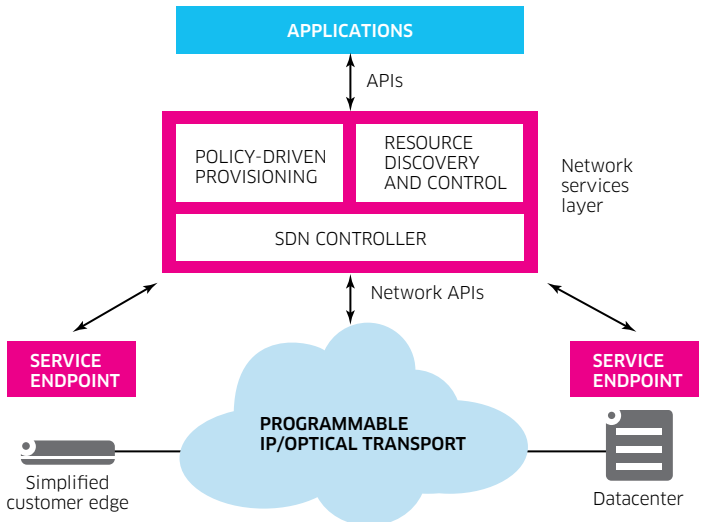
- Automate and scale the network service layer: Leverage policy-based service management to deliver dynamic network services with automated provisioning. Extract the network service layer and run it on virtualized compute resources to attain massive scale for the lowest cost.
- Simplify the service and customer edge: Externalize control planes to eliminate the need to run complex protocols at the customer service endpoint.
- Open up the service and transport layers: Accelerate innovation and enable rapid consumption of cloud services by offering programmability to applications through easy-to-use application programming interfaces (APIs). Offer enhanced monitoring and control of the transport network by providing network APIs at the IP/MPLS transport layer.

REALIZING THE VISION WITH ALCATEL-LUCENT

The Alcatel-Lucent SDN framework (see Figure 1) delivers on the vision of a responsive, flexible and open infrastructure by breaking up traditional IT/OSS-driven networks into three components:

- A programmable IP/Optical transport layer
- A virtualized and programmable network services layer
- A simplified customer edge

Figure 1. The Alcatel-Lucent SDN framework



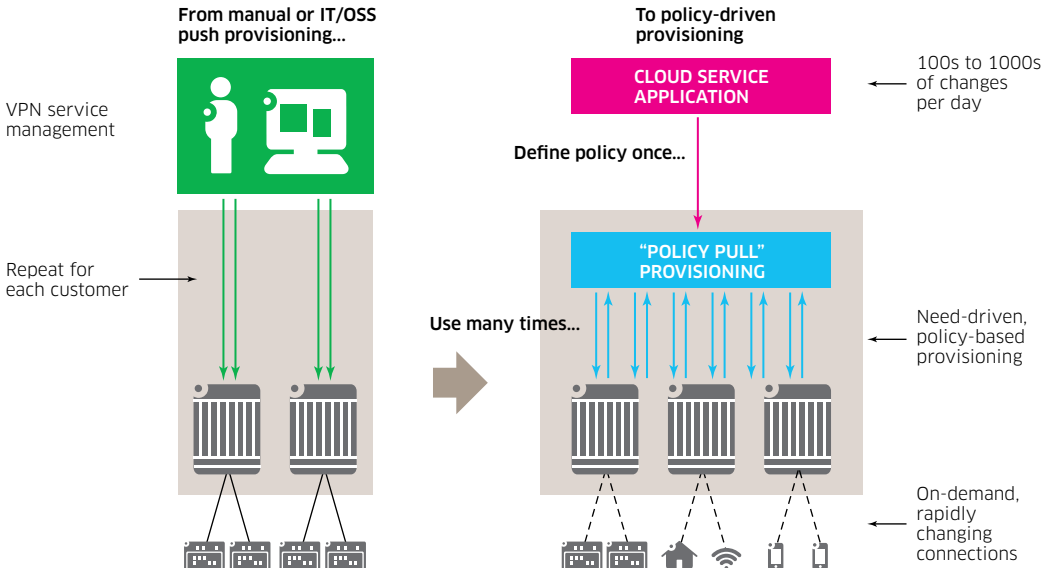
The programmable IP/Optical transport layer enables massively scalable, high-quality delivery of next-generation business network services. It provides a uniform and ubiquitous L0-L3 transport for enabling network service delivery across multiple administrative, technology and network domains. Key features include:

- Extraction of network service control plane and management layers — allows the WAN to run fewer service control protocols and requires less SP intervention for service turn-up.
- A distributed control plane — ensures IP network scale and stability across the entire network, end-to-end.
- Virtualization —enables creation of multiple transport planes, each tailored for specific QoS and SLA requirements.
- A set of standardized APIs (for example, OpenFlow™, NetConf, SNMP, RADIUS and DIAMETER) — opens up numerous capabilities for applications and the network services layer to make best use of available IP/Optical transport layer resources.

The network services layer is extracted from, and runs on top of, the programmable IP/Optical transport layer. Major capabilities include:

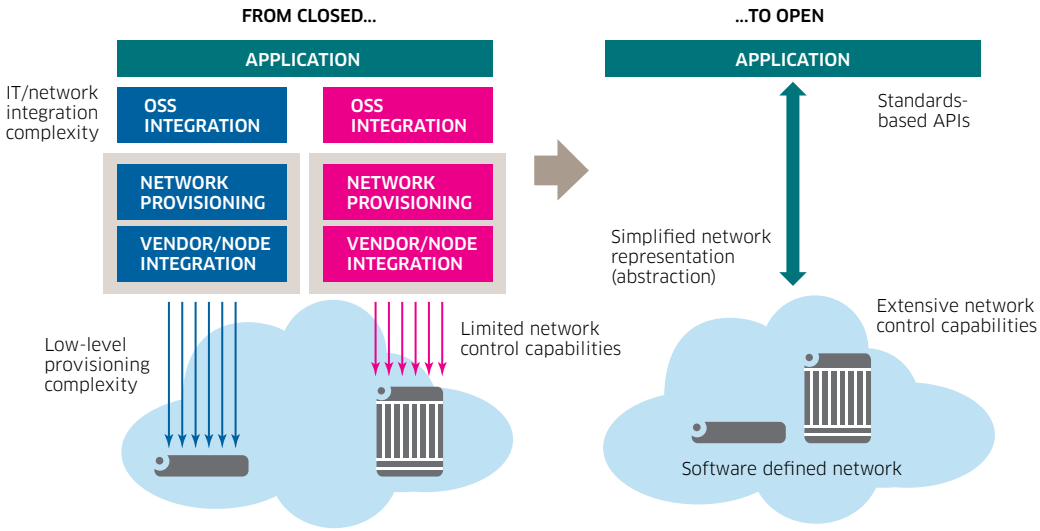
- SDN controller — provides the service control plane. It is responsible for building service topologies and programming the service endpoints to establish network services. Massive, multi-tenant scale is enabled by creating and managing services using field-proven service control solutions, such as Multi-Protocol BGP (MP-BGP).
- Policy driven service provisioning — a needs-based, policy-driven approach for service management allows applications to consume network resources on-demand. Services are defined as policies that can be rapidly instantiated on a mass scale based on customer, application or network triggers. Network operators can fully automate the turn-up of network services, providing the right service at the right time to the right user (see Figure 2).

Figure 2. Policy-based, automated service delivery



- Resource discovery and control functions— includes dynamic discovery of multi-layer topology, centralized control and allocation of resources, and the means to map service, application or user flows to specific transport planes.
- Standardized APIs with network abstraction — provides applications with the means to consume network services and control the network in a programmable and vendor/technology agnostic way. Policy-based definition of network services ensures alignment with application needs. This approach allows the creation of a high-level services directory and a service "language" that extracts the logic of a service request from the low-level network commands required to implement it (Figure 3).

Figure 3. Policy-based network service definitions



The simplified customer edge supports:

- Service CPEs with simple forwarding capability and service endpoints programmed and controlled by the network service layer— enables new Software Defined VPN (SDVPN) services for SPs that are optimized for operational simplicity and lower CPE hardware costs.
- Virtualized network functions — Such as firewall and network address translation - can be turned up and chained rapidly.
- SDN programmability allows CPEs to be configured as L2 or L3 devices for maximum deployment and upgrade flexibility.

Breaking up traditional networks into the three major components detailed above allows each component to leverage the hardware platform that can best serve its processing requirements. For instance, the IP transport forwarding plane can continue to leverage the throughput, density and power efficiency of network processor units (NPUs) to support ever-changing and growing cloud traffic levels quickly and cost-effectively. The network services layer can use virtualized compute platforms to achieve massive scale for the lowest cost.

LEVERAGING THE POWER OF SDN TO DELIVER CLOUD-OPTIMIZED BUSINESS NETWORKS AND SERVICES

Alcatel-Lucent will be delivering a comprehensive set of solutions to optimize networks for cloud applications and services inside the DC, between DCs and across the SP WAN. The first Alcatel-Lucent SDN solution, as provided by our SDN focused venture, Nuage Networks, is initially targeted at DCs where it fully virtualizes and automates any network infrastructure, providing instant network service delivery to thousands of tenants.[1]

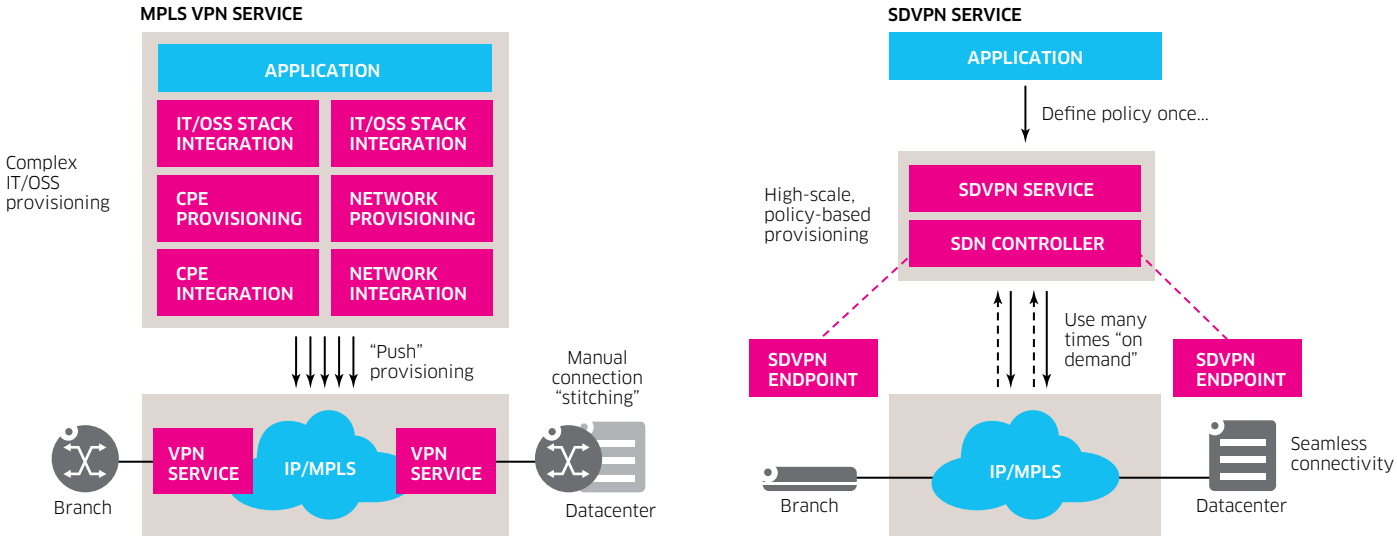
In future releases, Nuage Networks will extend the SDN framework to the WAN to deliver SDVPNs, as described below.

Cloud-optimized business network services with SDVPNs

Today's business network services are constrained by the following limitations:

- Long IT/OSS integration cycles slow down innovation, limiting SP competitiveness and revenue potential.
- IT/OSS or manual provisioning systems designed for tens of VPN changes per month cannot keep up with the rapidly changing connectivity needs of cloud-based services. Multi-step network provisioning processes that force customers to wait for days or weeks for service activation are at odds with cloud service delivery expectations that are measured in seconds.
- The cost and complexity of traditional CPE routers quickly consume operating and capital budgets.
- When additional services like firewall, load balancing and other security services are layered on, more equipment is required and service turn-up becomes even more complex.

Figure 4. Software Defined VPNs complement traditional MPLS VPNs



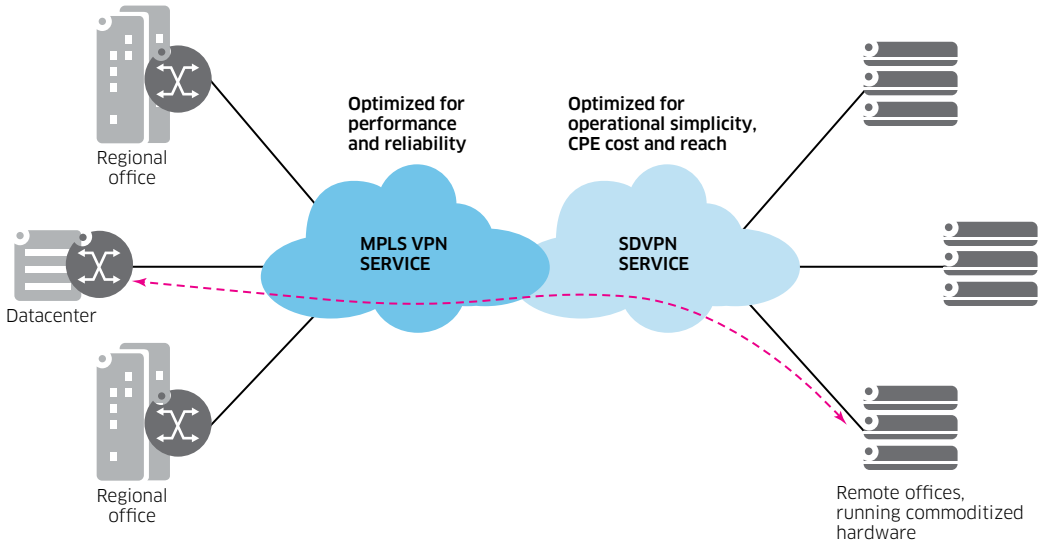
[1] See www.nuagenetworks.net for more on DC solutions.

To resolve these problems, Alcatel-Lucent developed the concept of SDVPNs (see Figure 4). With SDVPNs, the service endpoint moves from the Provider Edge (PE) router to the virtualized CPE which also contains a simplified forwarding capability. Both software elements are programmed and controlled by an external network service controller that communicates with peer network service controllers to create scalable VPN federations. Seamless connectivity between traditional MPLS VPNs and SDVPNs is provided to ensure end-to-end services.

The SDVPN approach for connecting enterprise sites to each other and to cloud resources provides many benefits:

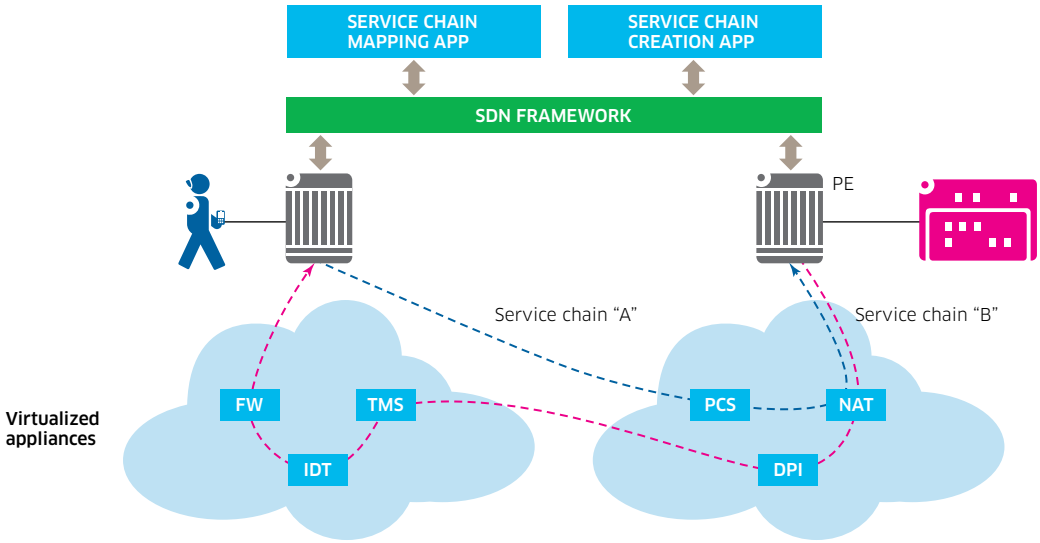
- SPs can maintain high performance MPLS VPN connections at regional offices and DCs while instantly creating new SDVPN connections on demand at offices where the need for operational simplicity and low cost outweigh all other considerations (see Figure 5).
- The use of commoditized and simplified CPE platform at each office eliminates the need for expensive and proprietary branch routers.
- Service provisioning speeds up dramatically and operational costs are lowered through CPE-triggered policy-based provisioning.
- The time and costs associated with IT/OSS integrations are significantly reduced through network programmability and abstraction. The innovation cycle shortens considerably, improving SP competitiveness in the fast-moving cloud services marketplace.

Figure 5. Creating new SDVPN connections on demand at branch offices



In addition to the above benefits, SPs can quickly up-sell value-added services by rapidly chaining advanced functions to their network services (see Figure 6). The use of general-purpose compute platforms for advanced services at the DC eliminates the need for expensive service appliances.

Figure 6. Up-sell value-added services by chaining advanced functions to network services



Simplify access to virtualized applicances via intelligent steering

- Centralized topology view/control simplifies service chain creation
- Need-driven, policy-based provisioning increases subscriber scale

Use cases

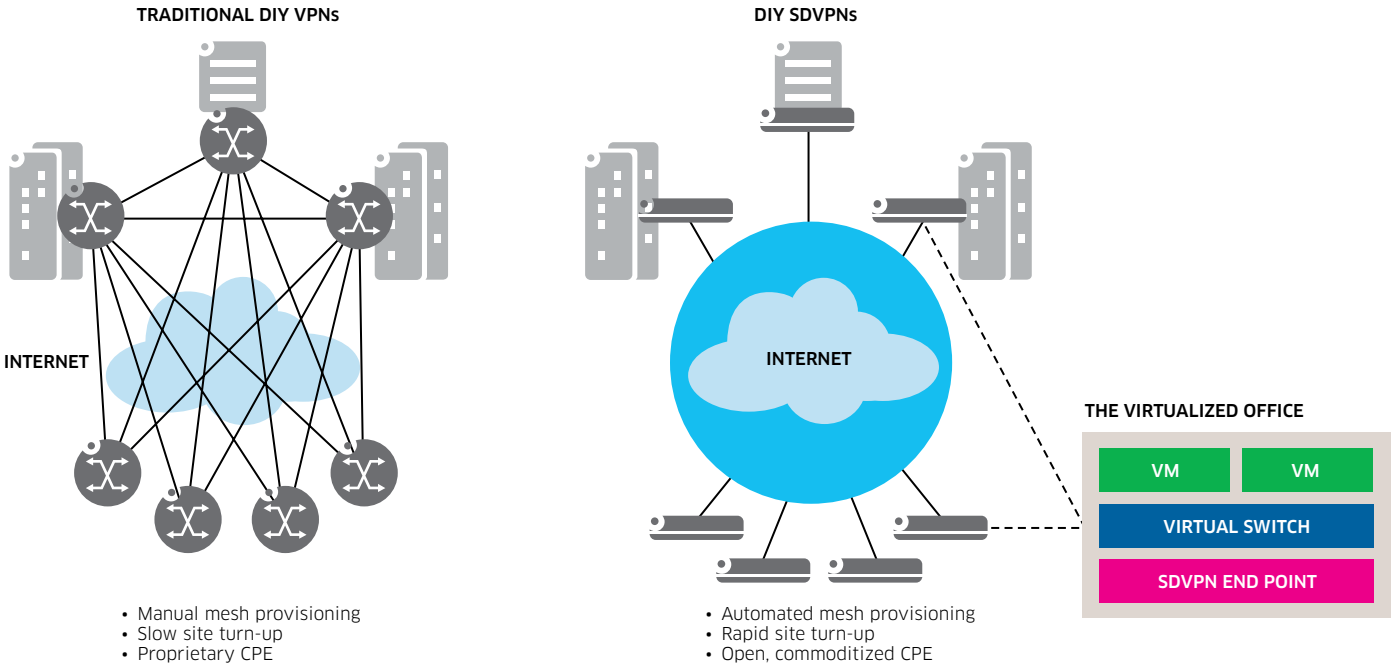
- Parental control and other consumer services for mobile and residential customers
- TMS, IDT, firewall and other enterprise services for business customers

Cloud-optimized DIY SDVPNs for enterprises

Enterprises that choose to implement their own do-it-yourself (DIY) VPNs as opposed to purchasing VPN services from providers can also benefit by switching to SDVPNs. Most DIY VPN approaches today (such as SSL and IPsec) require expensive, proprietary routers at each enterprise site. To ensure any-to-any connectivity, enterprise networking staff must manually provision a complex mesh of tunnels between sites. As each new site is added, new tunnels must be manually provisioned to every VPN endpoint the site must connect to. Provisioning is a complex, time-consuming affair with significant delay between connectivity requests and their availability.

With an SDVPN approach to DIY VPNs, automated provisioning of tunnels eliminates the need to perform this task manually. Full connectivity — between all sites and to public, private and hybrid clouds — is established at startup. Connectivity is dynamically adjusted as new sites are added to the enterprise network. As more virtualized appliances, such as firewall and WAN optimization, are implemented on standard servers, enterprises can begin the shift from closed, proprietary routers to open, virtualized CPEs based on commoditized hardware. See Figure 7.

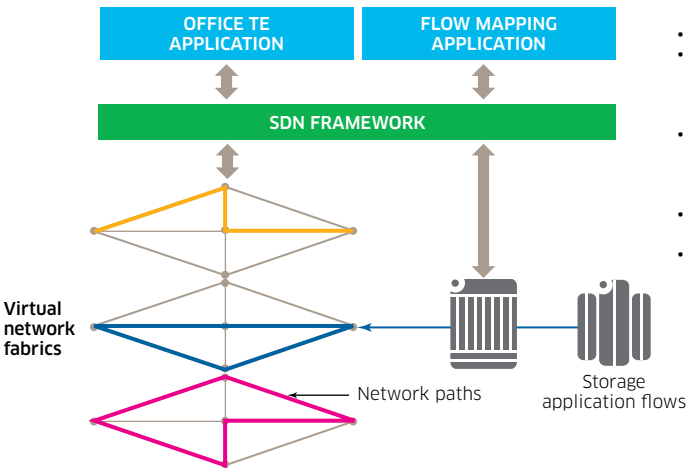
Figure 7. Comparing traditional and Software Defined VPNs for DIY



Assured services with flow-steering

Exposing network APIs to applications allows them to establish multi-layered, traffic-engineered service planes that are tailored to meet the SLA requirements of specific applications, services or enterprise customer workloads. Service planes can be engineered for on-demand enterprise storage and database replication (that is, time slice, low QoS) or high-volume low-latency financial data flows (that is, high speed, very low latency). Operators can steer traffic to service planes that match the unique SLA requirements of mobile backhaul, Wi-Fi® offload, residential Internet and content delivery network traffic in a multiservice IP/Optical transport network. Network operators can monitor service plane utilization offline and make real-time adjustments to ensure that SLA targets are met, and that optimal network utilization is achieved (see Figure 8).

Figure 8. Assured services with flow steering



Run networks hotter
- Partition network into virtual fabrics
- Dynamically monitor virtual fabric utilization and adjust network policies

Generate new revenue
- Market virtual fabrics attuned to diverse needs: QoS, time slice, capacity

Use cases
- On-demand connectivity for storage and database replication
- On-demand connectivity for high volume, low latency financial data flows

ALCATEL-LUCENT SDN SOLUTIONS

To provide SPs with the opportunity to participate in the cloud and offer high-value services to their customers, Alcatel-Lucent is transforming the network into a dynamic, virtualized network fabric that is agile, open and seamless. To accomplish this, Alcatel-Lucent is building SDN solutions branded as Nuage Networks. These solutions create a virtualized, muti-tenant network services layer built across a programmable and virtualized IP/Optical transport network.

With deployments in 400 networks worldwide, across a myriad of applications, innovations like the Alcatel-Lucent FP3 network processor[2], the Alcatel-Lucent 1830 Photonic Service Switch[3], the Alcatel-Lucent Service Router Operating System[4] and Alcatel-Lucent Service Aware Manager[5] are ideally placed to serve as the foundation for the IP transport layer.

With the Nuage Networks SDN solutions applied inside the DC as well as across the wide area network, Alcatel-Lucent is uniquely positioned to lead the industry in changing the way networks are built and operated in the cloud era. Service providers will be able to extend their service offerings to deliver network connectivity more dynamically and efficiently, with better performance and lower costs. Their business customers will be able to move from a complex, expensive and static network to one that is highly programmable and dynamically adjusts to their IT demands.

[2] Alcatel-Lucent FP3, the world's first 400G network processor: www.alcatel-lucent.com/fp3
[3] Alcatel-Lucent 1830 Photonic Service Switch: www.alcatel-lucent.com/products/1830-photonic-service-switch
[4] Alcatel-Lucent Service Router Operating System: www.alcatel-lucent.com/products/sros
[5] Alcatel-Lucent Service Aware Manager: www.alcatel-lucent.com/SAM

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