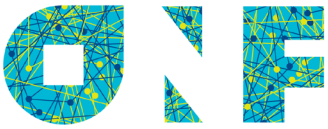

OPEN NETWORKING
FOUNDATION

How OpenFlow™-Based SDN Transforms Private Cloud

ONF Solution Brief
November 27, 2012

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Executive Summary

Private Cloud is transforming Enterprise IT, enabling the infrastructure to more effectively respond to changing business needs and reduce overall costs. As IT departments migrate from their traditional role as infrastructure operator to service provider for internal Lines of Business (LoBs), current generation networks are unable to keep up with the demands.

A new network architecture, Software-Defined Networking (SDN), has emerged as the foundation for Private Clouds. SDN enables Private Clouds to share infrastructure resources, scale them on demand, automate operations, and be more responsive to dynamic business demands while maximizing resource utilization.

Software Defined Networking implementing OpenFlow delivers substantive advantages for Private Cloud, including:

- Openness
- Streamlined Automation
- Granular Policy Enforcement
- IT Service Customization
- Resource Optimization

Trends in the Private Cloud

IT managers have been forced to cope with shrinking budgets and headcount. Rising user expectations have created the need for rapid deployment of new applications, service transparency, service quality, and secure access regardless of physical location. Industry trends, including virtualization and cloud computing, are forcing a change to traditional data centers.

As the data center evolves, so must the data center network. Legacy data center networks use hierarchical tree structure networks optimized for Client/Server (north-south) traffic patterns. Such architectures are too complex, costly, and rigid for today's dynamic computing environments. Network managers have responded by over-provisioning data center networks, and severely constraining workload mobility and flexibility, when the goal is to connect servers to servers and servers to storage. In effect, the legacy network has become a barrier to business innovation and competitiveness.

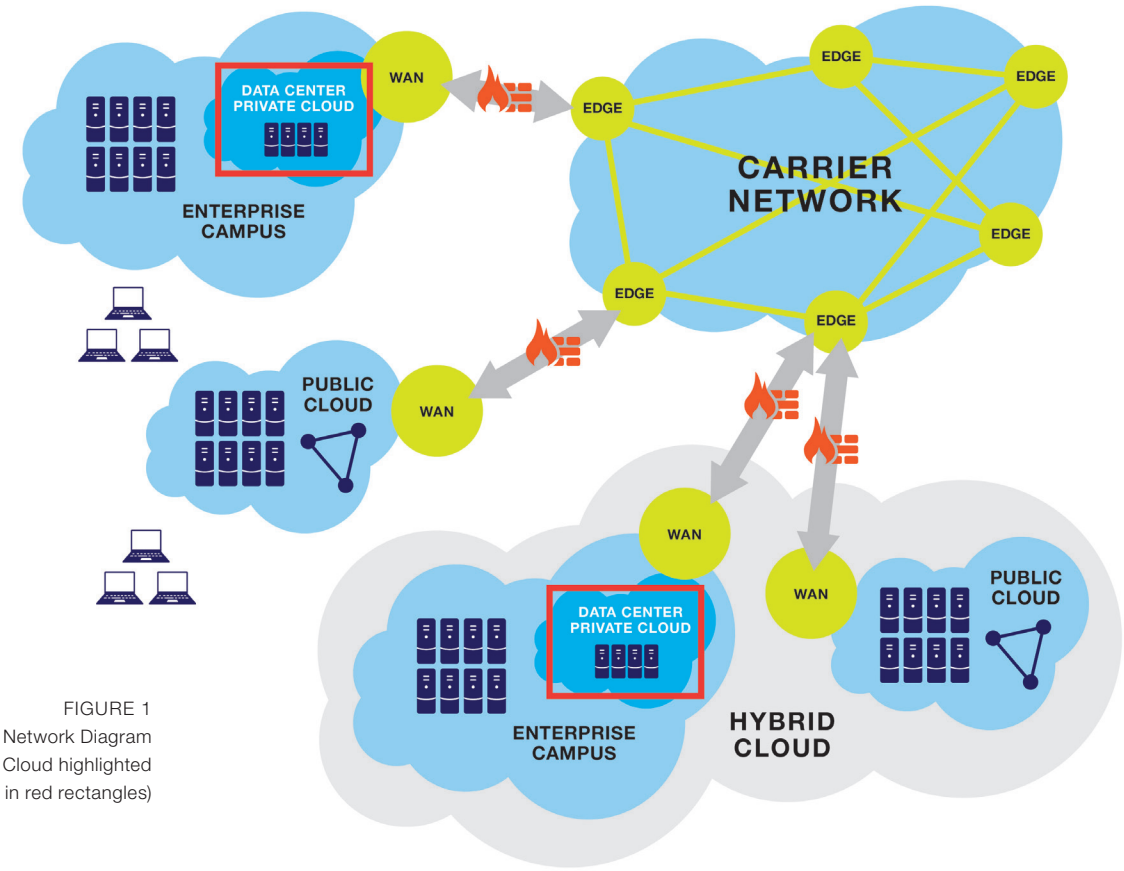

FIGURE 1
Network Diagram
(Private Cloud highlighted
in red rectangles)

Enterprises across diverse geographies and industries are adopting Private Cloud as a way to reduce costs and complexity while rapidly scaling their data center and application infrastructures.

Private Clouds transform Enterprise IT from infrastructure operator to internal service provider where resources are controlled by a single administrative domain and made available to users on an as-needed basis via programmatic interfaces.

Private Clouds allow Enterprise IT to rapidly respond to changing user requirements for new applications, network services, and devices with minimal cost and complexity.

Network Limitations and Requirements

Private Clouds require a network architecture that adapts to the elastic demands of diverse, increasingly mobile applications. Key communications requirements include flexible path management, fine-grained policy enforcement, network-wide automation, and multi-vendor interoperability. Another critical requirement is orchestration to enable IT and network operators to share and provision network resources based on business and operational objectives. Orchestration streamlines operations and optimizes resource utilization without compromising service quality.

Private Clouds balance networking economics with the user experience and productivity to provide significant benefits to Enterprise stakeholders from the executive suite to the mobile user.

Conventional Data Center networks cannot adequately support Private Cloud architectures resulting in:

- Long provisioning cycles
- Limited bandwidth scaling and elasticity
- Constrained ability to support diverse operational and application requirements
- Suboptimal utilization of compute and storage resources because of network rigidity
- Poor operational efficiency and increased complexity and risk

Legacy networks lack the virtualization and automation tools common for server and storage technologies. Consequently, the network must be over-provisioned to address current needs, as well as anticipated capacity growth. In addition, conventional network management is constrained to statically configured policies, vendor-specific deployments, and device-centric configuration.

OpenFlow-Based SDN Transformation

Software-Defined Networking (SDN) is an emerging network architecture where network control is decoupled from forwarding, network services are abstracted from the underlying infrastructure, and network behavior is directly programmable, as depicted in Figure 2.

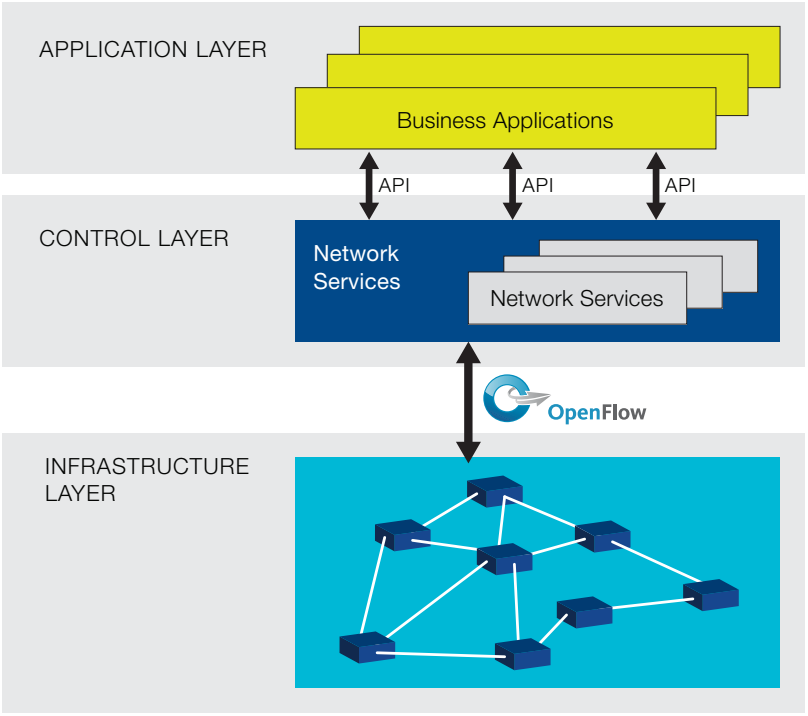

FIGURE 2
Software-Defined Network Architecture
(Refer to ONF White Paper for details)

The Open Networking Foundation (ONF) is chartered to create SDN standards and encourage adoption of SDN. OpenFlow is the first SDN standard, and interconnects the control and forwarding layers for SDN architectures using an open protocol.

IT SERVICE CUSTOMIZATION

SDN introduces unprecedented programmability to tailor the network to the needs of the diverse user base throughout the enterprise. Granular levels of control enable flexible policy management and tiered service levels necessary to address the needs of each department. Through SDN, the network can be programmed to support different network characteristics per user group (e.g., bandwidth, QoS) even if they share the same infrastructure and network policies (e.g., security).

For example, Operations may need a highly reliable network connection across a global supplier network, while Marketing needs bandwidth-on-demand and flexible traffic prioritization for a webinar presented only once a month. Through SDN, the network can adapt by minimizing the bandwidth needed to support Operations, while simultaneously delivering on-demand bandwidth and QoS for Marketing.

RESOURCE OPTIMIZATION

SDN expands network visibility, as the Control layer is capable of centralizing the network view of both the physical and virtual infrastructure. Full visibility facilitates resource optimization that in turn enables elasticity. As a result, network-aware services can be developed that can better adapt to the available network capacity, policy, or performance.

Network-wide visibility also enables the Control layer to efficiently manage network resources, which can be programmatically classified, viewed and re-allocated. For instance if the workload in one data center is higher than another, application workloads can be migrated wherever resources are available, even in a remote data center.

POLICY ENFORCEMENT

By leveraging the centralized network configuration and multi-layer flows, granular policies may be established for logical groups that combine MAC and IP addresses along with application characteristics represented in the flows. Strict logical partitioning is especially important for maintaining security, regulatory, compliance, and management policies, which must be simultaneously enforced.

For instance, R&D users may require security policies to protect Intellectual Property (at the application level), whereas HR employees must comply with local and national regulations (at the user level).

AUTOMATION

SDN also enables unprecedented automation, which is especially critical for Cloud services. Access to the Control Layer may be delegated to network-aware services (e.g., load balancing, traffic engineering, etc.), which remains under complete supervision of network management in accordance with the appropriate policies.

By abstracting network services from the network details, any changes requested by Cloud applications (e.g., OpenStack) are automatically reflected in the Forwarding plane. Such requests for network capabilities will be integrated into Cloud orchestration systems that will coordinate with compute and storage resource management to achieve application-layer goal.

Furthermore, the SDN architecture shields applications and network services from changes to the underlying physical infrastructure, setting the stage for self-service provisioning and management for on-demand Cloud services.

OPENNESS

One of the most important aspects of SDN is the potential to open proprietary solutions. Openness is achieved through standardization. OpenFlow is the first SDN standard having been adopted by more than 80 industry leaders. Such wide support, driven by a broad cross-section of end-users and vendors, encourages innovation and allows customers to select best-of-breed solutions that best address their needs. Ultimately SDN attains the business agility that Enterprises seek in the long-term.

Benefits

In a recent IDC Survey (December, 2011), a select group of CIOs identified 'Invest in Cloud Services' as their top IT Initiative, with a projected ⅓ of their overall budgets by 2014. Limiting Cloud adoption are a number of network challenges, including bandwidth limitations, provisioning times for new services, and network security. Software-Defined Networking has been designed to address these challenges, and enable the network to more effectively respond to the needs of the business.

OpenFlow-based SDN delivers the following benefits for Private Cloud networks:

- **IT Service Customization** is achieved through enhanced programmability and granular policy management delivered by SDN, accelerating the time to market for new and enhanced communication services.
- **Resource Optimization** is improved by centralizing network intelligence for both the virtual and physical infrastructure, allowing the network to readily adapt to available capacity and performance. SDN offers the potential for a 25-35% improvement in bandwidth utilization in the Data Center, and up to 50% in the WAN, where bandwidth is typically statically allocated.

- **Policy Enforcement** is more flexible as OpenFlow transcends the traditional layer boundaries, which enables more granular policies to be enforced for both logical and physical partitions. This enables Enterprises to more rapidly comply with the increasingly complex set of regulations they are confronted with today, and in the future.
- **Automation** is facilitated through the SDN architecture which abstracts the network details from the applications and network services that are accessing them. With an automation framework vs. traditional network management, new applications and resources may be activated within a matter of hours vs. days or even weeks in order to satisfy user expectations for Cloud services.
- **Openness** is provided through an open architecture facilitated by OpenFlow, which promotes multi-vendor interoperability and affords customers control over the features roadmap. Adoption of Open Source Software is also encouraged in the open SDN environment.

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The Open Networking Foundation is a nonprofit organization founded in 2011, whose goal is to accelerate the adoption of open SDN. ONF emphasizes the interests of end-users throughout the Data Center, Enterprise, and Carrier network environments.