# SDN-BASED CLOUD INFRASTRUCTURE AS A SERVICE (IaaS)

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# EXECUTIVE SUMMARY

Virtualized programmable networks – or Software Defined Networking (SDN) – have finally begun to realize their promise of moving beyond traditional hardware limitations and enable enterprise networks to be simply and remotely provisioned.

SDN was designed to offer a dynamic and flexible network architecture that protects existing investments while enabling the network to grow and evolve. SDN achieves this flexibility by separating the network control plane from the physical or virtual networking component. Unlike a traditional network fabric, it is well-suited to the dynamic requirements of virtualized and cloud architectures. SDN architectures allow administrators and programmers access to a northbound set of application programming interfaces (APIs) to define and manage physical and virtual infrastructures southbound.

The Open Networking Foundation calls SDN "the new norm for networks" and according to the International Strategy and Investment Group "... business momentum as well as investor interest in SDN has grown faster than any other emerging enterprise technology we have seen in recent years (e.g., perhaps ~10% of IT buyers interested 1 year ago, ~1/3 interested 6 months ago, and over 50% today)."

SDN offers significant advantages over traditional, hardware-based topologies and the time has come for service providers (SPs) to consider how to make use of its unique advantages. Yet before this can happen, SPs need to reevaluate their current networking architectures in light of the requirements of cloud computing and virtualization and decide how to integrate this new technology.

The Zimory Cloud Suite is industry-leading cloud management software that allows administrators to control their virtual data centers from a single user interface rather than requiring multiple programs and dashboards. The benefits Zimory Cloud Suite offers to virtual servers are now available for virtual switches and controllers: it turns virtual networks deployed in enterprise data centers around the globe from static systems into dynamic, centrally configurable ones.

SDN architectures offers the potential for networks to evolve into extensible service delivery platforms capable of responding rapidly to changing business, end-user, and market requirements, which is a paradigm shift in how networks are managed.

This paper provides a brief technical overview of SDN architecture and its potential and details how the Zimory Cloud Suite extends that potential by bringing together the best of SDN, cloud and infrastructure as a service (IaaS) management in a single system.

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# SDN: A BRIEF INTRODUCTION

In an SDN architecture, control plane functions are separated from the physical switch and are performed by an external controller (e.g., a standard server running SDN software). This external controller can centrally manage both physical and virtual switches and routers – and, in a limited capacity, firewalls – using a common protocol. The de facto standard protocol for linking disparate networking components together is the community supported OpenFlow, which has emerged as the basic building block of many SDN solutions.
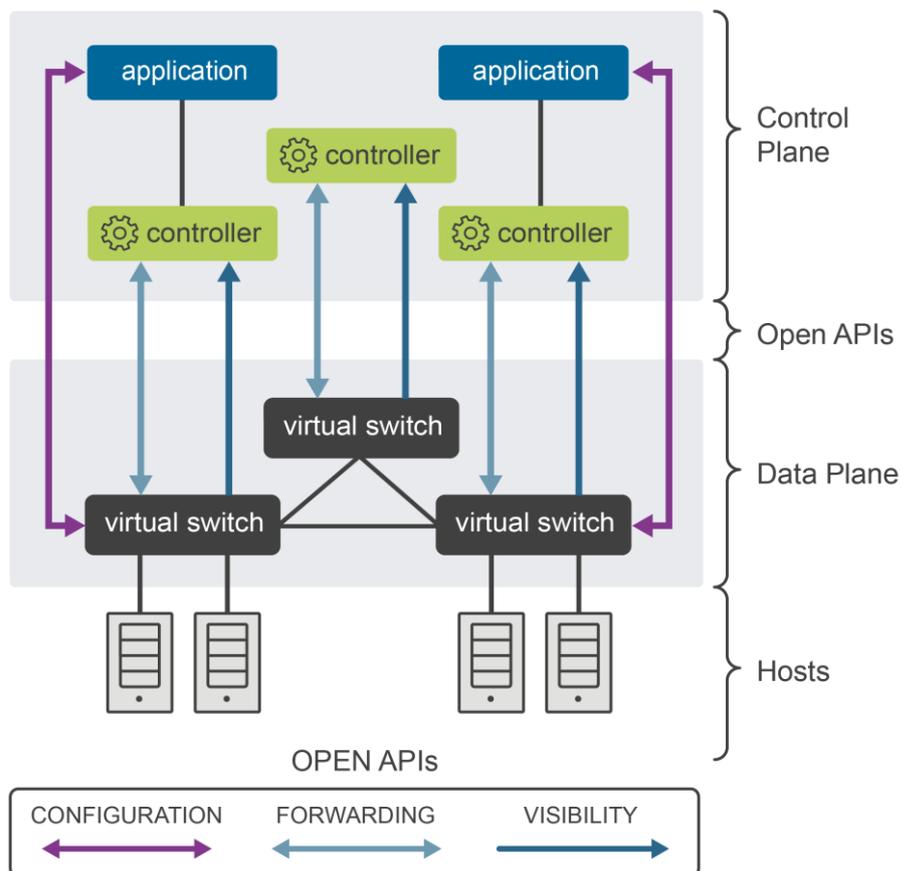


OpenFlow-enabled SDN is currently being integrated into a variety of networking hardware and software, delivering substantial benefits to cloud providers, enterprise data centers and telco carriers. This includes many physical switches, including those from Juniper, Dell, HP and IBM as well as the software OpenvSwitch, an opensource virtual switch. Most hypervisors already support some form of SDN, and though they have yet to agree on a standard implementation, support is growing.

VMware, which currently supports their own distributed virtual switch as well as the Cisco Nexus 1000v, has also embraced the OpenFlow standard with their recent purchase of

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Nicira, a leading network virtualization company. Microsoft Windows 2012 Server and Hyper-V also provides sophisticated virtual networking and has also promised support for the Cisco Nexus 1000v virtual switch.

Big Switch Networks, the leading independent provider of SDN controllers and one of the driving forces behind enterprise SDN implementations released the code for their popular floodlight controller as open source. Big Switch Networks and the open-sourced Floodlight controller are technically sophisticated examples of SDN products currently available in stand-alone solutions. Each one, however effective, is still concentrated only on the control of network components. Full integration with IaaS software remains.

# A NEW NETWORKING ARCHITECTURE

## TRADITIONAL NETWORKS

The networks in most datacenters have changed little in the last two decades. They focus on the movement of packets between distinct hardware units and are scalable in terms of performance, but are expensive and lack the ability to adapt to new applications. For example, the administration of a switch might properly focus on the restriction of ports according to a VLAN or a L3 subnet. SDN allows administrators to manage the flow of network traffic in a more holistic manner and in real-time, reconfiguring topologies dynamically and as needed. This change in perspective has enormous consequences for cloud architects and administrators.

## AN (IN)ABILITY TO SCALE

As demands on the data center rapidly grow, the network must also grow to keep pace. However, networks become vastly more complex with the addition of hundreds or thousands of network devices that must be configured and managed. IT has also relied on link over-subscription to scale the network, based on predictable traffic patterns; however, in today's virtualized data centers, traffic patterns are incredibly dynamic and therefore unpredictable, making congestion more likely.

To achieve robust and responsive IT infrastructures in large-scale implementations, traditional approaches to networking must be reconsidered. The scaling required for virtual and cloud networks cannot be managed with manual configuration, nor can changes be made rapidly enough in a hardware-only network architecture.

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## VENDOR (IN)DEPENDENCE

Any proposed new architecture must be vendor independent. The Open Networking Foundation has insisted on this idea from the start and OpenFlow is the basic building block of many SDN solutions.

Enterprise SPs must offer high-performance, low-cost connectivity solutions across masses of physical hosts. As is the case with hypervisors, there are several competing software networking technologies promoted by different vendors which must both interoperate and be able to be centrally managed. Support for standards and open APIs like OpenFlow are one method of avoiding vendor lock-in. Until that becomes the accepted norm however, SPs must make sure that they do not limit short- or long-term flexibility.

## TOWARD A SINGLE FABRIC

Many SPs who have begun to integrate SDN solutions have adopted a hybrid networking management approach: one set of tools for physical infrastructure, another for virtual switches, routers and firewalls and perhaps another data center infrastructure management (DCIM) solution for energy and facilities management.

### Scalability and Automation

The goal of a modern SDN data center implementation is to:

- dynamically modify bandwidth among existing data center locations
- activate new service connections on demand
- provide real-time feedback and visibility into the utilization of interconnection services for more efficient traffic loading by cloud applications

### Controller-managed topologies

At the heart of a OpenFlow SDN is the ability to address networking flows through APIs in software switches and routers using central controllers. Developers and administrators can centralize the management and control of networking devices from multiple vendors – both hardware and software – through a common interface.

By shifting the object of infrastructure configuration from physical devices to dynamic flows and network traffic management, OpenFlow alters the way that applications such as can visualize, control and secure virtual infrastructures. It enables rapid innovation through the ability to deliver new network capabilities and services without having to configure individual devices or wait for vendor releases; This is the benefit SDN promises to bring to networking.

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# THE CHALLENGES OF CLOUD NETWORKING

Modern virtualized infrastructures present a challenge to traditional hardware-based networks in at least two ways. First, virtual machines (VMs) need to both move between physical hypervisors and sometimes between different physical locations or data centers, which is challenging for traditional, manually configured infrastructures. Traffic flows often change dynamically as VMs are relocated, virtual servers are added and topologies change; network configurations need to change in real-time with them.

Second, network management is usually separated from the administration of virtual servers – sometimes not even controlled by the same admins. If the ultimate the goal is to consolidate all cloud services under a single, centralized, easy-to-manage control, then the two biggest dangers are lack of standards and vendor lock-in.

The Open Networking Foundation has described today's networks as "relatively static as IT seeks to minimize the risk of service disruption." This characterization is especially apt as SPs grapple with the unique problems of virtual and cloud infrastructures.

As large SPs offer public cloud services and dynamically provision virtual machines to their customers, the limitations of standard L2 and L3 topologies become immediately apparent: customer servers are no longer grouped into easily managed racks and clusters. In addition, virtual servers may come on- and off-line in a far more random and dynamic manner. Dynamic provisioning also bypasses traditional, manually configured VLANs and routed subnets which form the core of most traditional data centers.

By contrast software-based network virtualization can improve server utilization, help optimize bandwidth usage and provide tighter integration with storage , security, configuration management databases (CMDBs), and more. An SDN allows applications to control flows across virtual and physical switches programmatically and in real-time – a goal traditional networks have been unable to achieve.

# ZIMORY CLOUD SUITE

Zimory Manage and Zimory Connect, the two main core components of the Zimory IaaS suite, offer end users and administrators a single interface to manage virtual infrastructure. By extending support to SDN controllers, Zimory provides networking with the same flexibility and vendor-independence it currently offers virtualized server environments.

## SDN and a Centralized Management of all IaaS

The real promise of SDN is ultimately to manage the entire network via a single common interface – dynamically and programmatically. In the same way that Zimory Cloud Suite currently manages the virtual infrastructure, Zimory plus SDN will eventually be able to manage the entire data center infrastructure.

## MULTI-TENANCY

Most enterprise SPs have shared networks which serve groups of users with different applications and performance requirements. Key operations that appear relatively straightforward – such as steering a customer's traffic flows to provide customized performance control or on-demand delivery – are very complex in traditional network topologies.

## DYNAMIC SEGMENTATION

The standard approach to segmenting traffic is to statically declare a set of network flows which specify the ports accessible on a given VLAN ID. A dynamic approach, on the other hand,  uses a controller to manage authentication of users and use the knowledge of the users' locations for tagging traffic at runtime.
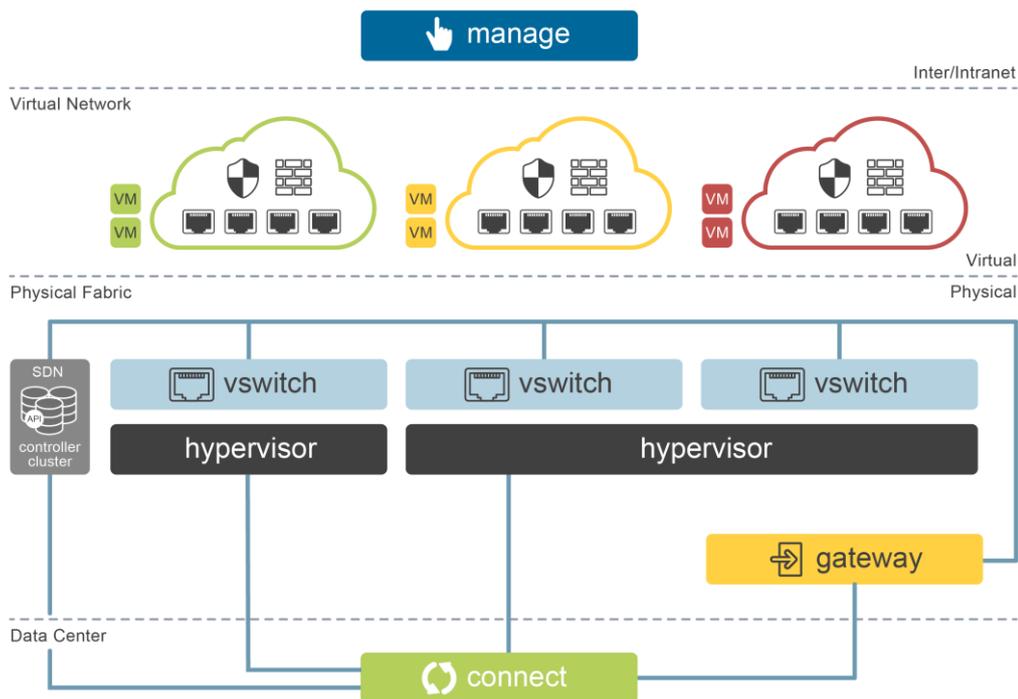
## EMERGING STANDARDS

The SDN market is still immature: competing standards though OpenFlow-enabled devices and controllers are deployed in test and production environments, and Cisco has announced a competing standard called Open Network Environment (CiscoONE).

Zimory Cloud Suite supports the hybrid model by maintaining a vendor-neutral approach and by offering a central interface to all virtualized components in the enterprise infrastructure. The Suite supports Cisco Nexus 1000v switches in VMware directly and OpenvSwitch via the Floodlight Controller for Xen and KVM virtualization. In addition to CiscoONE and OpenFlow, Zimory will soon support Nicira and Big Switch Networks – both based on OpenFlow. As Cisco and Microsoft further define and finalize their SDN offerings, Zimory will integrate support for these as well.

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## Directly Programmable and Centrally Managed

Zimory Cloud Suite enables SPs to administer their switches and network components (including Zimory Gateway) from the same interface used to manage storage and VMs. This allows SPs to move closer to the ultimate goal for their distributed virtual data centers, to have a single central interface for all virtual and physical components and for those systems to be able to reconfigure themselves dynamically and without significant administrator intervention.



Zimory Cloud Suite uses a standard programming interface to customize and control virtual networks as well as manage rapidly changing topologies. Automation and management is improved by using standard APIs to abstract the underlying networking details from the orchestration and provisioning systems and applications.

# CONCLUSION

Software defined networking is an idea whose time has come. Cloud deployments and the dynamic requirements of virtualization demand a flexible and easily modifiable networking infrastructure to be successful. Zimory Cloud Suite gives service providers the ability to control and optimize both physical and virtual infrastructures and administer everything from a single user interface. This enables SPs to design, deliver and scale dynamic cloud services rapidly and efficiently.

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