Software-Defined Networks Powered by VellOS

Agile, Flexible Networking for Distributed Applications
Vello’s SDN enables a low-latency, programmable solution resulting in a faster and more flexible network, in keeping with the rapid changes that IT administrators are familiar with in the world of server virtualization.

Software-defined networking (SDN) represents a significant architectural shift that translates to direct customer benefits and opens up the networking market to new product innovation. SDN brings cost-effective and flexible sharing of physical resources to the switched network and puts the “brains” of the network into a central controller where switching flows are centrally calculated based on application-defined parameters, and then transferred to the distributed switching architecture. The emerging OpenFlow protocol provides a foundation to SDN for automated provisioning of network resources and for delivering network services in real-time within a virtualized cloud networking environment.

The value of SDN in the enterprise lies specifically in its ability to provide automated configuration across the entire cloud network so new services and end systems can be deployed rapidly and operational cost can be significantly reduced. SDN also allows secure and automated network isolation. Virtual network segments can be configured centrally, for example on an organizational or entity basis, and enforced within and across cloud data center networks.

Vello’s Software-Defined Network architecture is founded upon a real time network operating system, VellOS, that hosts the SDN control functions and manages the policies and routing of flows globally across all of the OpenFlow enabled networks in the enterprise or service provider data centers. Open application programming interfaces (APIs) open the network to customization for applications and the single, logical network view presented by SDN greatly simplifies integration with third party applications and policy engines.

For example, an innovative SDN application is Vello’s Remote Data Replication Manager, which can deploy, monitor, and manage replication network services for storage applications used across separate storage facilities to achieve disaster recovery and business continuity objectives. This application integrates VellOS SDN control and OpenStack’s storage cloud and demonstrates the value of SDN automation of network services with cloud orchestration for operational simpliit.

With a VellOS powered SDN for unified flow optimization and management, enterprise data center operators and cloud service providers can begin to enjoy Google scale benefits in simplicity, reliability, scale, and efficiency. With a VellOS SDN, innovation in application and network service extends across all of your data centers.

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1 Urs Hölzle, *OpenFlow @ Google*, Open Networking Summit, April 17, 2012
Cloud Networking Challenges

To date, server virtualization has been the driving force behind cloud networking. Today, virtualized servers are flexible in their deployment, and have the ability to move to other physical server platforms. From the end-customer viewpoint, each system is still separate with its own network and storage; however, the divider is not a server rack, but a secure multi-tenant environment. The servers, networks, and storage are all still securely separated, in some cases much more so than in a traditional environment. And finally, when an enterprise business unit needs more servers, they only need to request provisioning of a few more virtual machines in the existing environment, instead of having to order new physical equipment for every deployment.

While virtual servers can be provisioned through virtualization or cloud orchestration tools, data center networking equipment and control path policies must be managed at a device or network flow level.

While network management software can simplify the process, it only provides a graphical user interface (GUI) for centralized management of individual devices and control planes. Network configuration changes remain a tedious process and heterogeneous networks must still be managed through multiple network management systems.

Enterprise data centers also typically suffer from a range of network performance challenges. Any traffic congestion or networking hardware problem has a multiplicative effect that impacts the performance and latency of all traffic traversing the same devices.

Existing element-oriented network management approaches make control and access of the shared private cloud network infrastructure for multi-tenant applications, such as departments and subsidiaries, cumbersome and time-consuming. It is often difficult to implement consistent and concurrent policies required to partition cloud networks by traffic type, for example, server-to-storage traffic or client-server data, to ensure compliance with regulatory and audit requirements. In addition, existing manual VLAN-based network segmentation approaches are incompatible with enabling flexible, dynamic multi-tenancy, which is an inherent requirement for cloud computing.

The above-mentioned challenges of network management, performance and security are exacerbated when geographically disparate data centers are used as the resource pool for elastic computing or for geographic redundancy as shown in Figure 1. This implies that VMs have the ability to migrate to and from the data centers without violating application service level agreements (SLAs), which challenges IT network managers with the problem of stretching VM mobility boundaries across data centers. Virtual machine mobility across cloud data centers requires architectures that balance workload mobility, disaster avoidance, and disaster recovery objectives while coordinating workload and storage movements across a network core using flexible data center extension.

Cloud-ready networks require global-level scalability and resiliency, which translates into extremely large, elastic VM mobility domains where network control typical extends over multiple active switches, thus simplifying configuration and control. The goal is to manage multiple switches as a combined entity to create an ultra-reliable virtual switching fabric comprising hundreds to thousands of switch ports at 10GbE or higher bandwidths.
Software-Defined Networking for Private Clouds

Server virtualization is a proven approach for cost-effectively sharing server resources and flexibly adapting computing resources to changing user and application requirements. However, the dynamic nature of VM workload mobility, proliferation, and scale complicates network administration and network policy management. With SDN, centralized network intelligence and control present a single logical switch view which simplifies cloud VM administration and network policy assignments even across multiple data center sites.

Shared storage in a virtualized server environment enables VM mobility as well as storage management and utilization efficiencies. VM mobility and storage mobility are both needed to deliver true business agility for the cloud infrastructure owner and tenants when the compute and storage pools aggregate and span across data centers. On demand provisioning of applications and permanent storage data may involve mission critical information, which requires data protection.

Physical infrastructure and storage resources can be policy configured to support on-demand provisioning and subscription to replication services. Such replication services efficiently require remote storage and low latency connectivity to be dynamically provisioned. SDN integration with the cloud provisioning applications facilitates delivery of high value and specific SLA replication flows, which can be metered and billed accordingly.

VellOS Delivers Application Optimized Networking

The VellOS SDN architecture encompasses a range of Vello products that seamlessly operationalize software-defined networking for private cloud networks. VellOS scales intra- and inter-data center networking by automating the application-optimized deployment of network capacity as well as assured and instantaneous access to cloud network resources.

Designed as a simplified architecture for cloud networks, VellOS SDN leverages the OpenFlow protocol to allow cloud providers to more easily deploy and manage multi-tenant network infrastructure. VellOS is designed to allow cloud data centers to streamline network management through greater levels of automation while lowering operating costs and reducing the time required for delivering network services. Its aim is to allow customers to more easily upgrade and add functionality to their cloud networks while protecting their network investment.

By abstracting the network definition and control layer, VellOS also automates the deployment of new network-based services without requiring the addition of discrete network devices for such functions. In addition, it allows application-optimized paths that are concurrently latency and bandwidth-sensitive to be programmed into intra and inter-data center networks, while hiding the physical network and protocol details, which is one of the key goals behind SDN.

Remote Data Replication Network Services for Cloud Users

RDRM, or Remote Data Replication Manager, is a VellOS SDN application for an OpenFlow-based Software Defined Network. RDRM enables OpenStack cloud administrators to configure, monitor, and manage replication flows to support the storage replication applications providing disaster recovery services between data center sites. When the tenant orders a compute instance, Nova Compute, and associated persistent storage, Nova Volume, RDRM also enables OpenStack cloud tenants to request synchronous or asynchronous replication services for the Nova volume.

For the tenant, RDRM delivers a rapid network infrastructure response to a service request with a pre-defined SLA. For the administrator, RDRM provides simple scalable service provisioning for hundreds or thousands of users while also providing summary and detailed views of service performance holistically across the network. OpenStack is an infrastructure-as-a-service open source cloud initiative with more than 150 companies behind the initiative including DELL, HP, and IBM. With OpenStack any organization can deliver cloud computing services compatible with Amazon Web Services on x86 architecture hardware and Linux operating systems. RDRM addresses a significant service omission for data protection for the leading cloud providers using OpenStack. In addition, RDRM can be added to multiple cloud orchestration stacks to support other popular server virtualization and administration frameworks.
**VellOS Use Cases**

The following scenarios illustrate the use of VellOS in enterprise, private cloud environments, for business continuity as a service and data center interconnect network virtualization.

**Business Continuity as a Service:**

Private and public cloud data center operators have a need to provide disaster recovery solutions for their customers. For example, the cloud or storage administrator needs to protect a new data set for a mission critical application. This entails establishing a new replication stream to a remote Disaster Recovery site.

In addition, the cloud or storage administrator needs to protect the critical replication flows against network failures. He or she also needs to ensure that the network keeps up with growth in storage data traffic and there he must set up network policies to increase bandwidth incrementally without impacting existing replication flows.

Figure 2 illustrates how VellOS and an SDN application, RDRM, can provide integration between the cloud orchestration stack and multiple data center OpenFlow enabled networks and cloud resources. In this case, OpenStack is the cloud orchestration stack and Nova Volumes are afforded replication as a service via self-service Horizon menus for the cloud tenants. Additional cloud orchestration stacks may be integrated with VellOS SDN network services.

![Figure 2.](image)

VellOS enables integrated application layer and storage connections over data center interconnect wide-area networks (WANs)
Data Center Interconnect Network Virtualization:

Cloud data center interconnect networks are used to carry traffic for a range of different applications each with a different set of performance, latency, security, and resiliency requirements. VellOS enables a single shared physical infrastructure to optimally handle different types of traffic, such as virtual machine migration or storage replication traffic, using application-level policies. It allows the creation of virtual networks over a shared inter-data center physical network and enables enterprises to provision and control such virtual networks based on a unified view of all network flows, applications, content, and/or by specific divisions or groups within the enterprise. Enterprise IT can optimize the data center local and inter-connect networks centrally and with greater simplicity when the entire data center network is based upon OpenFlow. Another benefit of operating the internal multi-data center networks with OpenFlow is the ability to automate via SDN policy actions network optimizations through the data center gateways to maximize efficient use of valuable inter-site bandwidth. Figure 3 illustrates the network flow complexity associated with isolation and multi-tenant traffic while maintaining the logical relationships of distributed multi-tier distributed server applications and the associated application data. By virtualizing the network, the VellOS SDN controller can optimize the network for each application's requirements for latency, isolation, security, bandwidth, periodic behavior, or migration globally through each data center gateway.

Figure 3.
VellOS enables application-aware network policy automation for simplified management of network flows end-to-end
Conclusion

The VellOS Software-Defined Network controls Vello and open standard OpenFlow third party products to seamlessly operate, virtualize, and program networking for private and public cloud networks. VellOS supports innovative network service creation such as RDRM to facilitate application performance optimization and simplicity.

VellOS utilizes software-defined networking to deliver a number of key benefits to private and public cloud computing providers:

- VellOS allows cloud data centers to streamline network management through greater levels of automation while lowering operating costs and reducing the time required for delivering network services.
- By abstracting the network definition and control layer, VellOS automates the deployment of new network-based services without requiring the addition of discrete network devices for such functions.
- VellOS allows application-optimized paths that are concurrently latency and bandwidth-sensitive to be programmed into intra and inter-data center networks, while hiding the physical network and protocol details, which is one of the key goals behind SDN.
- VellOS Remote Data Replication network services automate and scale storage services and provide a valuable new solution for disaster recovery using SDN.

VellOS enables scale out bandwidth and scale up network services for multiple data center networks to provide google-scale benefits for enterprise class budgets.

About Vello Systems

Vello Systems is a privately held Silicon Valley company pioneering in the emerging field of software-defined networking by building networks controlled by a powerful network operating system, VellOS, to simplify connectivity of compute and storage resources within and between data centers.

Vello delivers solutions for latency sensitive applications for data center networking including market data content delivery, storage replication and big data connections.

Based in Menlo Park, California, Vello Systems provides networks to enterprise and service provider customers in North America, Europe, and Asia.

To learn more, contact your Vello Systems sales representative at sales@vellosystems.com, or visit us at www.vellosystems.com.