

Ciena D-NFVI Software

In a fast-changing business environment, the ability to improve digital application performance and provide secure remote access to employees is mandatory. Enterprises need to keep their customers' Quality of Experience (QoE) high, create better offers and solutions, and control their operational cost. The network infrastructure that supports their business needs to be able to adapt, align with their strategic objectives, and support the technologies that deliver value.

A legacy access solution based on single function physical devices does not have the flexibility and agility needed. The evolution of the network edge to enable Virtual Network Functions (VNFs) is the best approach to guarantee that any functionality required from the network can promptly be deployed, any change done quickly, and the network is ready to adapt.

Openness is essential to guarantee the best of infrastructure

No single vendor can offer all the virtual functionalities that an enterprise needs to support their business. Most times, the same enterprise can have different needs in different moments. An open approach to virtualization is essential to guarantee the liberty of choice and a future-proof solution. It not only enables the enterprise to choose what vendor offers the best functionalities, but also the ability to change the vendor without impacting the infrastructure in place or disrupting the business. A closed, proprietary VNF is no better than the legacy single-purpose physical device. Openness is one of the best keys to a successful function virtualization strategy.

Ciena D-NFVI Software—A complete, modular solution for Distributed VNF deployment

By bundling VNFs and Containerized Network Functions (CNFs) with advanced connectivity services, today's service providers can field a virtually limitless portfolio of enhanced services that build reliable revenue streams and limit the endless

Features and benefits

- Allows rapid deployment of applications, dynamically activating or deactivating instances as required by user demand
- Lowers costs via the reduction/elimination of dedicated function hardware and associated ongoing maintenance tasks
- Leverages low-cost, off-the-shelf x86-based hardware while not sacrificing performance or reliability
- Avoids manually intense, error-prone operational processes and costly truck rolls
- Eliminates vendor lock-in via an open architecture, allowing best-in-breed technology adoption
- Increases revenues by offering new services addressing changing user demands

upgrade cycles that only add cost and inefficiency to the network infrastructure. Network Functions Virtualization (NFV) enables agility and scalability to facilitate network and service transformation.

The NFV challenge

While operators and enterprises have recognized the value of virtualized functions in reducing costs and enabling innovative methods of adding value to their networks, early implementations have been challenging. As VNFs are distributed across the WAN in large volumes, services are hard to monitor, automate, and debug. They also sacrifice significant performance when compared to their more hardware-centric alternatives. Compatibility among tools, lack of comprehensive APIs, and the resulting vendor lock-in also pose problems that can break the business case for Distributed NFV (D-NFV). This is where NFV can help. D-NFV is a complete, open, modular solution for distributed VNF lifecycle management.

The D-NFV Infrastructure (D-NFVI) software is purpose-built to address these problems, allowing for rapid implementation of the latest advances in networking technologies. It provides flexibility in deployment for today's critical VNFs while addressing lifecycle orchestration, eliminating vendor lock-in, and tackling cost challenges.

Distributed or centralized NFV

Which functions or combination of functions to deploy and where to deploy them tends to be a key question facing the industry. Distributed or centralized models exist with each finding its place in the next-generation network landscape.

Certain functions are best centralized in a data center or other colocation environment to derive the best use of shared resources (physical memory, compute, storage, software licenses, etc.). This pool of resources can thereby be allocated dynamically among services and users, increasing economies of scale.

But many VNFs naturally belong distributed to the edges of the network. These might include security features like encryption, routing, or WAN optimization features such as SD-WAN functions.

However, traversing the WAN entails its own set of challenges, including efficient scaling capabilities, unpredictable latency, and spotty reliability. Industry-promoted implementations based on tools such as OpenStack and Open vSwitch have

come a long way, but key challenges in resolving the WAN issues remain.

Networking: VNFs vary widely in their network demands. And with D-NFVI, reliable and low-latency WAN connectivity is a critical requirement. OpenStack (Neutron) is unable to manage WAN capabilities, yet operators need a platform that will set up and manage LAN/WAN infrastructures in a programmable manner.

Automated Lifecycle Management (LCM): Carriers need an NFV platform to automate not only deployment and scaling but also many lifecycle operations related to complex carrier applications with cradle-to-grave management functions.

NFV infrastructure operations: D-NFV introduces unique challenges that will impact operational processes and support systems. With functions at different physical locations, adds/changes/deletes, and associated processes should be performed remotely whenever possible to avoid truck rolls across the supported coverage area.

High-performance data planes: Some carrier-grade network functions (such as DPI, media gateways, session border controllers, QoS SLA traffic management) are implemented on purpose-built hardware appliances that offer high routing and switching throughput. Running these on existing COTS servers with existing hypervisors can lead to significant and unacceptable performance degradation.

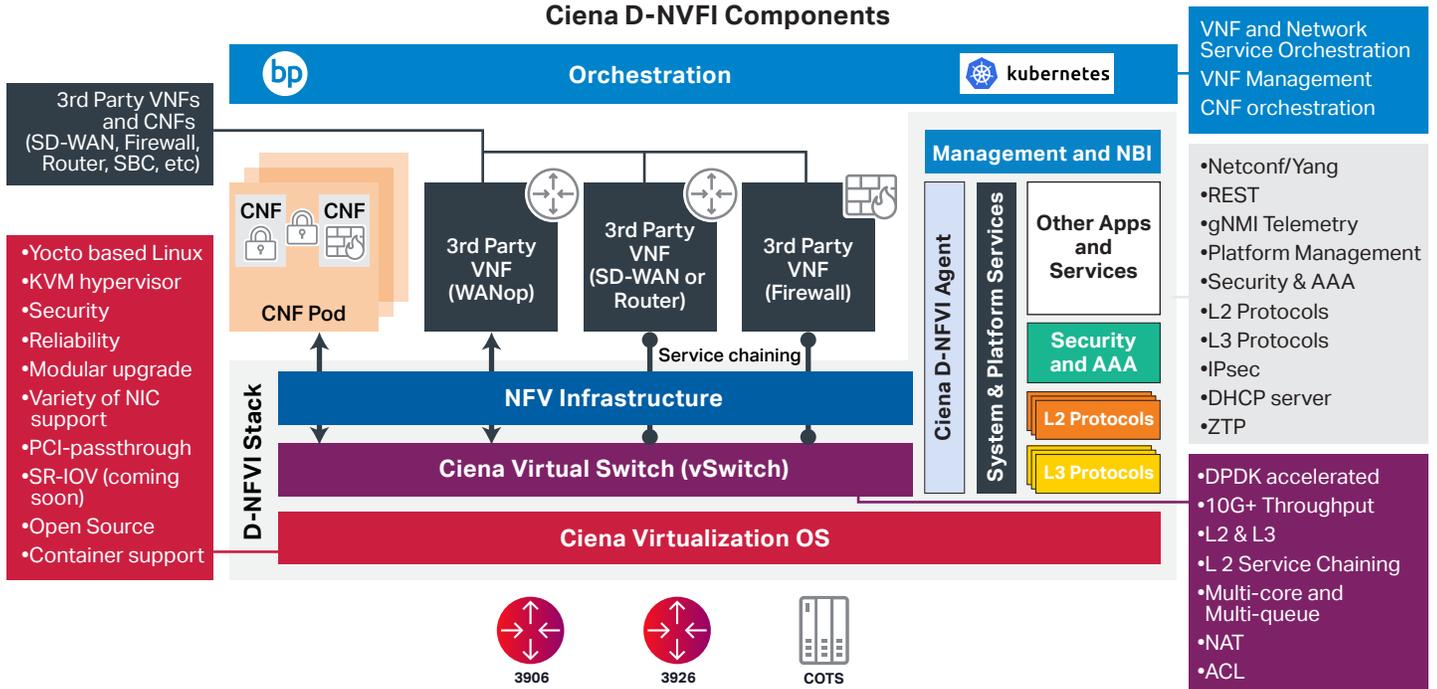
In summary, operators need an NFV platform that provides compute, storage, and network resources for the VNFs, a centralized platform for NFV Orchestration (NFVO), along with a centralized VNF Manager (VNFM) that performs VNF LCM. The hybrid model has some VNFs hosted in a distributed model and some VNFs hosted in a centralized model. This is likely the model that most service providers will end up deploying, as the cost and performance of some VNFs are location specific.

Ciena D-NFVI Software

Ciena D-NFVI Software comprises four main components:

Ciena Base Virtualization OS includes Ciena-supported distribution of a virtualization Operating System (OS) for x86 hardware, which includes the base Linux OS, Kernel-based Virtualization Machine (KVM) hypervisor, and Linux Container (LXC) support.

Ciena D-NVFI Components



It provides a highly secure, Ciena-supported system for virtual machines or containers to execute. It includes a KVM/Quick Emulator (QEMU) hypervisor as well as the libvirt virtualization API.

Ciena vSwitch provides MEF CE 2.0 functionality by Data Plane Development Kit (DPDK)-accelerated vSwitch for service function forwarding.

Ciena D-NFVI Agent is a virtualized infrastructure management solution based on direct orchestration that provides an OpenStack alternative purposely optimized for the D-NFV use case.

The Ciena D-NFVI Agent facilitates VNF lifecycle management by an orchestration system and provides a secure NETCONF/YANG interface that exposes the following hypervisor capabilities:

- Creation, deletion, and state management of virtual machines which map to domains in libvirt nomenclature
- Viewing, listing, and monitoring the virtual machines
- Viewing and monitoring the host resources and statistics

Ciena 3906 and 3926 Platforms

The 3906 and 3926 (39x6) are carrier-grade platforms based on the Service-Aware Operating System (SAOS) used in all Ciena packet switches, providing operational efficiency and consistent system attributes.

The D-NFVI Software Stack can also operate on commercial off-the-shelf (COTS) devices.

Ciena's Virtualized Edge Solution (VES)

As part of Ciena's Virtualized Edge Solution (VES), each D-NFVI component is licensed to operate individually or as a complete stack on a subscription or perpetual license basis. Any of the individual components can be substituted for a third-party or open-source-based alternatives such as Open vSwitch, or generic Linux distributions.

Upon this software foundation, multiple best-in-breed VNFs from a growing number of suppliers can be chained in innovative ways to quickly and cost-effectively create new service offerings that are highly differentiated and profitable. Encryption, firewalls, enterprise routing, WAN optimization, SD-WAN, and similar functions have been recognized as far more cost-effective if integrated into an x86 server platform that avoids dedicated appliances.

Service providers can thus differentiate their service offerings, improving revenue per user—minimizing churn, delivering increased value to end-users, and increasing their overall revenue opportunities. Enterprises benefit from the lower CAPEX and OPEX made possible by the elimination of complex and over-featured hardware solutions that add little value to their requirements.

Some example of VNFs tested with Ciena D-NFVI



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Ciena D-NFVI is an open and continuously growing ecosystem

The Ciena D-NFVI solution enables service providers to offer a rich service portfolio and gives the enterprise end-user freedom of choice—allowing users to mix solutions from different vendors or build any homemade functionality. Ciena already has an extensive list of tested VNFs with multiple partners and a solution ecosystem that is exploding. The Ciena D-NFVI solution is not limited to pre-tested VNFs and is open to integrate new partners selected by customers.

Ciena advantage

Ciena D-NFVI Software addresses these challenges by allowing robust deployment of functions without the typical performance compromises. The network operator has the option to centralize functions and distribute others with open APIs as required for an optimal cost and performance. Specifically:

- The Ciena D-NFVI Agent provides the support for direct orchestration of VNF functions at the CPE using industry-standard interfaces to the NFV orchestration and management function. The Agent ‘racks and stacks’ the VNFs (operations like create, list, change, delete, etc.) and ensures they are performing adequately for the application involved. Coordination with the orchestration and management function then ensure end-to-end function performance at scale.
- The Ciena vSwitch offers higher performance and more fully featured (e.g. with sophisticated VLAN manipulations, OAM functions, etc.) than industry offerings. For example, Open

vSwitch implementations are data center-centric and hard to debug. The Ciena vSwitch complies with MEF CE 2.0 services specifications, allowing for creation of a rich set of managed Ethernet services of growing popularity to enterprises large and small, and unavailable in traditional data center scenarios.

- The Ciena Base Virtualization OS is a lightweight OS adapted specifically to D-NFV purposes, eliminating excess functionality that only serves to add cost and sap performance from the edge-based implementations. It is also less susceptible to security vulnerabilities that exist in full OS implementations. Its basis in Open Network Linux and KVM hypervisor ensures that the components vital to a mix of VNFs are available. Using Linux Foundation Yocto templates, requirement-specific embedded Linux distributions are created as needed for each VNF-based service—and no more.

The solution can be combined with Ciena’s Blue Planet® Multi-Domain Service Orchestration (MDSO) capabilities to provide an advanced software architecture with an open design concept capable of delivering a single comprehensive framework for NFV service delivery.

Whether using a Ciena end-to-end solution or leveraging individual components into a set of best-of-breed tools, the result is a solution that can be deployed across multi-vendor and multi-domain environments, and scaled on demand, leading to a dramatic transformation of how services are delivered and how networks are operated.

Technical information

Network Services

Network address translation (NAT)
DHCP client and DHCP server
MEF CE 2.0 compliant Ethernet services (E-line, E-LAN, E-tree)
Virtual routing and forwarding (VRF)
Untagged and VLAN tagging (802.1q)
LTE support

Virtualization Services

Support for qcow2, raw, img, ...VNF image formats
Virtual disk and ISO support
VPWS and VPLS based Service Chaining for VNFs
Cloud-init support
USB support for host and VNFs
Hugepages support
Multi-socket support

Data Path

DPDK accelerated vSwitch
Full L2 forwarding with MAC learning and VLAN tagging
Full L3 (IPv4 and IPv6) forwarding
Multi-core scaling of the vSwitch for higher throughput
1G and 10G port support (RJ45 and SFP+)
Port mirroring and packet capture
IPv4 ACL
Receive Side Scaling (RSS) for higher BW of virtual ports
PCI-passthrough and 48 vHost virtual interface support

Protocols

NTP for time synchronization
Static IP routing support
ISIS, OSPF and BGP routing support
LLDP support for link discovery

Management and Telemetry

SSHv2 based Netconf/YANG open interface
Console access to host (structured CLI) and VNFs
HTTPS based WebGUI
REST API NBI
gNMI/gRPC based telemetry
Alarms and remote syslog
Secure (TLS based) ZTP compliant to RFC 8572
SNMPv2 with DNFVI-specific standard MIBs

Security and Authentication

AAA with local authentication, TACACS+ or RADIUS
SSHv2 access control (RBAC)
IPSec with IKEv2 tunneling for management
AES encryption with up to 256 bit (aes256)
X.509 certificate management (PKIX)
OpenSSL based TLS secure channels for ZTP and telemetry

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