Virtual SD-Edge

Open, multi-cloud, secure routing
Highest performance at lower TCO

Virtual SD-Edge Open, Multi-Cloud, Secure Routing

In the ever-present quest to improve agility while reducing costs, enterprises large and small are capitalizing on the compelling benefits of virtualization and the cloud. In response, cloud and managed service providers are leveraging Network Functions Virtualization (NFV) to introduce new services to facilitate cloud migration. IP Infusion's Virtual SD-Edge is an open, highly secure, virtualized router that ushers in a new generation of cloud connectivity networks and services.

Benefits

Virtualized routers offer a number of advantages over traditional hardware-based routers, which are summarized in Table 1. By exploiting the benefits of virtualization, automation, and software-defined networking, virtualized routers offer significantly improved service agility, while driving down both capital and operational expenses.

Traditional Hardware-Based Router	Virtual Router	Benefits
Fixed form factors are expensive to deploy, maintain, and upgrade	Virtualized approach is easy to deploy and executes in general purpose hardware	Lower CapEx, OpEx, and faster time to value
Purchasing cycle is slow and expensive	Deploy and reconfigure on-demand	Higher service agility and lower TCO
Functionality and performance are limited to embedded capabilities upon installation	Scale, reconfigure, or upgrade on-demand	Higher service agility and lower OpEx
Large-scale deployments subject to prolideration of firmware versions	Centralized software management ensures each instance is up to date	Lower OpEx and higher availability
Designed for traditional networks	Designed for the Cloud	Higher service agility at lower costs

Table 1: Hardware-based vs. Software-based Routers

However, all virtual routers are not interchangeable. Significant expertise and tuning of the software-based forwarding plane is required to achieve performance on par with purpose-built appliances, especially in the virtualized environment. Extensive functionality beyond routing is required to address mission-critical use cases, especially security, address translation, performance optimization to name but a few. And ease of purchasing, deployment, integration, and support is expected in the cloud era.

The Virtual SD-Edge router addresses these issues, and offers a number of advantages summarized in Table 2.

Features	Benefits
Highly optimized forwarding plane (15+ years of tuning)	• Compact virtualized footprint • Highest performance per price point • CapEx reduction
Built on DANOS – first open source Network Operating System platform; widely deployed by AT&T	• Optimized for disaggregation and easy to integrate/automate • Proven in multiple white boxe use cases
Pre-integrated virtual router, firewall, VPN, performance optimization, etc. in a unified software package	• Simple to purchase, deploy, and operate • Automated Operations, Administration, and Maintenance (OAM) • Higher value than alternatives
Per vCPU licensing	• Simplified licensing • Exploits improvements in hardware at no additional costs
Full-featured Control Plane	• Enables a broad-range of cloud-networking use cases
Extensive High-Availability features	• Achieves carrier-grade availability
IP Infusion Advanced Network Services	• Carrier-grade support

Table 2: Virtual SD-Edge Virtualized Router Benefits

Optimized for Virtualization Efficiency

Performance in the cloud era is not solely about achieving the highest throughput. The predominant metric is efficiency – achieving targets for network performance, physical space, electrical power, and management while consuming minimal resources.

This is particularly the case for Virtual Routers, where enterprises and service providers alike incur direct costs for the cloud resources consumed. For Virtual (or Universal) CPE, NFV Infrastructure (NFVI) is inherently limited, and the challenge is to enable the most functionality in the lowest cost device.

Consequently, the Virtual SD-Edge software data plane has been optimized for efficient use of virtualization resources, whether in the public or private cloud, or NFVI, including vCPE/uCPE. Only a single virtual core is required to achieve up to 2 Gbps full-duplex packet processing, as verified by standard benchmark testing in accordance with RFC 2544 with IMIX (RFC 6985) packet size distribution). For 10 Gbps, full line rate throughput, only two virtual cores are required on a mid-to low-end x86 White Box.

The software data plane has been optimized for the virtualized environment over a decade utilizing DPDK and other acceleration techniques. Throughput has been validated to scale linearly with the number of virtual cores.

Target Use Cases

The Virtual SD-Edge virtual router may be hosted in a public, hybrid, or public cloud, extending WAN connectivity into the cloud. The comprehensive control plane, robust management plane, and open architecture may be tailored for a range of use cases for CSP/MSPs, Enterprises, and Cloud Operators.

Cloud Migration Use Case

Migrating enterprise applications and data to the cloud requires a means to interconnect the physical and virtual domains. The Virtual SD-Edge router offers an ideal set of comprehensive communications functionality and enhanced security in an integrated package.

Business does not pause to enable enterprise resources to migrate to the cloud. As applications are incrementally hosted, flexible networking capabilities are required to enable seamless (and of course secure) access to enterprise resources, no matter where they are deployed (see Figure 1).

Once deployed, enterprise data must be isolated from unauthorized access, by customers, partners, etc. but even within a particular company. Data/resource isolation is provided through routing constraints, policy, and security. Service providers also require multi-tenancy, which is provided at scale for enabling managed services.

Virtual SD-Edge, built upon the IP Infusion Control Plane, and DANOS Vyatta edition Network Operating System platform, offers comprehensive L2-L7 support, advanced network security, and ease of deployment, management, and maintenance, to enable effective cloud migration.

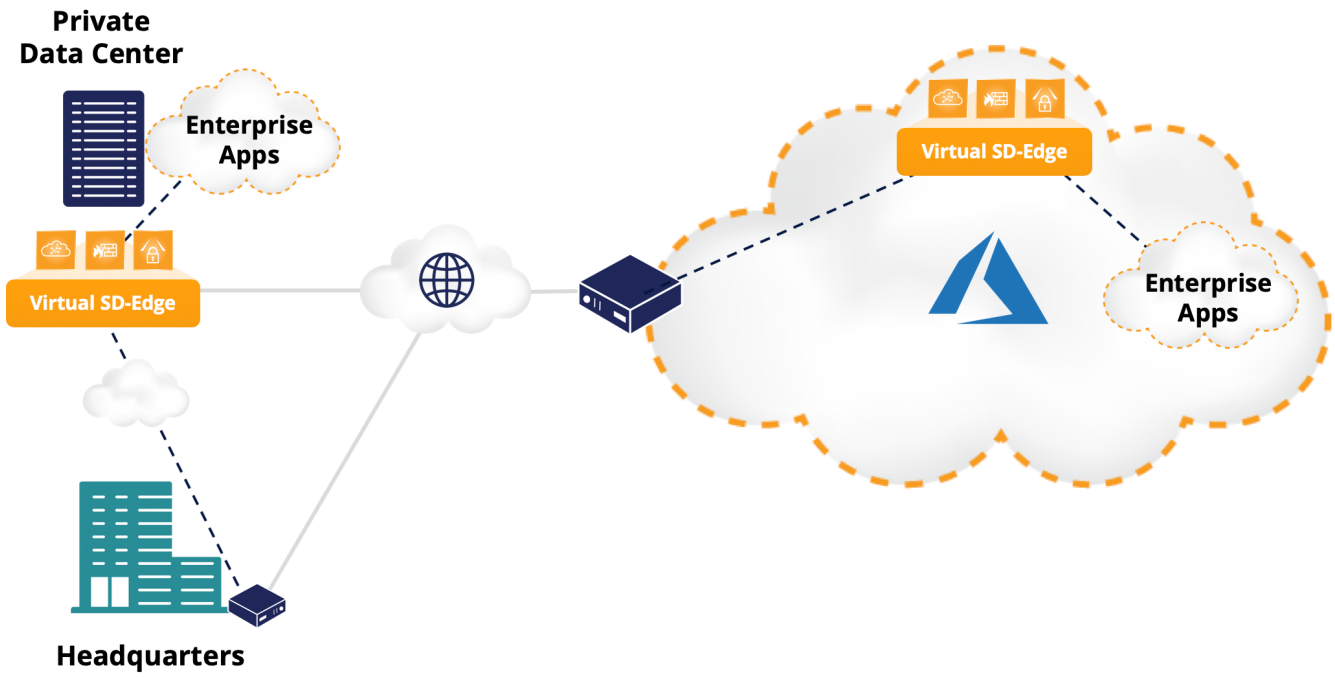

Figure 1: Virtual SD-Edge Cloud Migration Use Case

Branch-to-Cloud Use Case

As enterprises continue to outsource infrastructure (to the cloud), enhanced services such as SD-WAN, VPN, firewall, carrier grade NAPT, managed security, WAN Optimization, etc. (to MSPs), effective cloud connectivity become essential.

The Virtual SD-Edge router delivers highly cost-effective, secure and efficient connectivity between branch offices and enterprise resources hosted in the public, private, and/or hybrid cloud (see Figure 2). By providing comprehensive IPsec support, secure and ubiquitous VPN tunnels may be seamlessly extended into the cloud.

The Virtual SD-Edge solution includes a built-in stateful firewall and rich communications without additional charge. A rich set of standard management and orchestration interfaces and APIs are provided, to further reduce TCO.

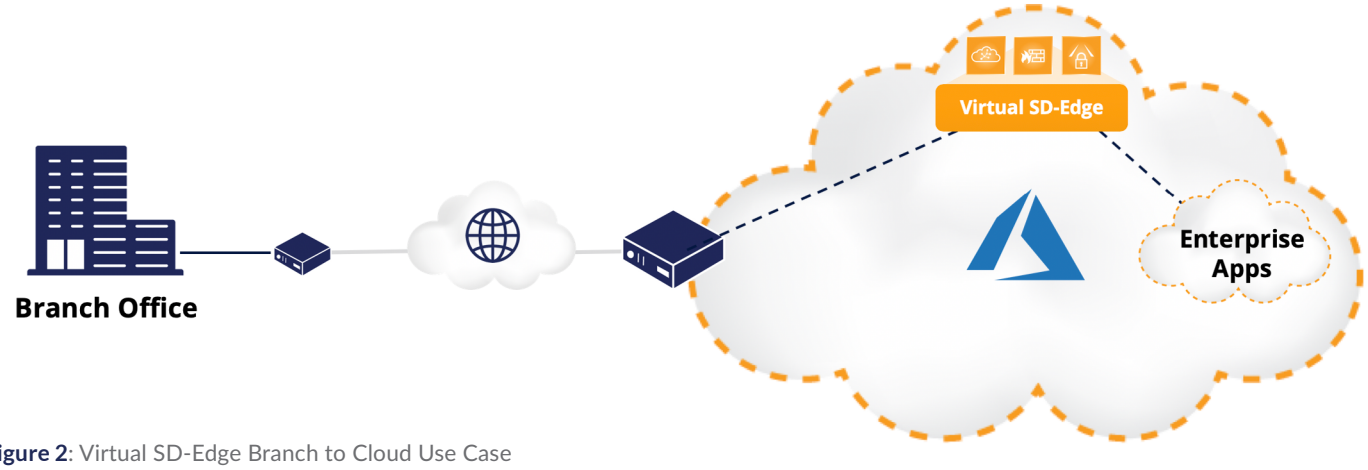

Figure 2: Virtual SD-Edge Branch to Cloud Use Case

Multi-Site, Multi-Cloud Use Case

For large and multi-national enterprises, enhanced connectivity is required to address the inherent complexity of the organization. Distributing applications among corporate headquarters, regional data centers that provide local access (and regulatory compliance) are the norm.

The ability for multiple sites to access enterprise resources that may be hosted in a range of public and private clouds is essential, as indicated in Figure 3.

The Virtual SD-Edge solution may be deployed on-demand, and hosted in a range of public and private clouds. Extensive routing and communications services may be tailored to the needs of each region or individual sites, enhanced by embedded security and performance services which are provided in a common package, that simplifies procurement as well.

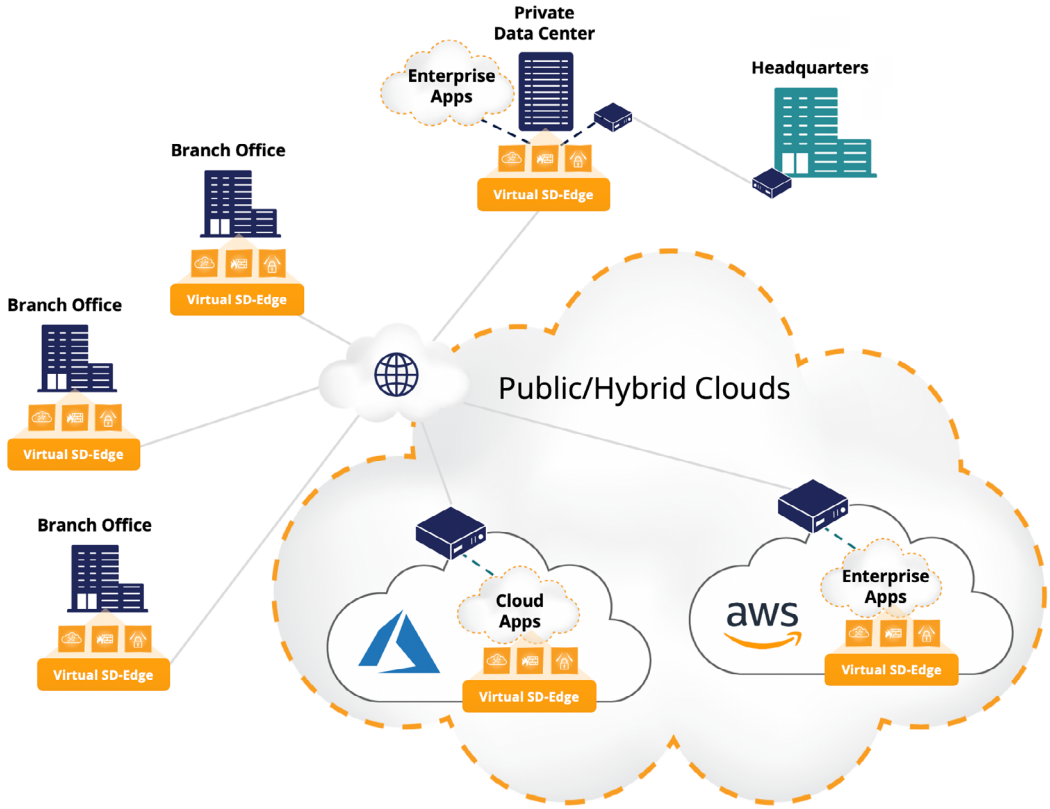

Figure 3: Virtual SD-Edge Multi-Site, Multi-Cloud Use Case

The Virtual SD-Edge virtualized router provided a low-cost yet flexible (and efficient) resource to support a range of router use cases, including:

1. High performance routing (BGP/OSPF/IS-IS peering router)
2. Route reflector
3. Application Layer Gateway (ALG) Firewall
4. Carrier Grade Network Address Translation (CG-NAT)
5. Virtual Provider Edge (PE) router (roadmap)

DANOS-Vyatta edition NOS Platform

DANOS-Vyatta edition (DVE) Software is the industry first commercially available disaggregated Network Operating System (NOS) for both wireless and wireline use cases. The open architecture (see Figure 4) paves the way towards network disaggregation, without compromising communications functionality.

DVe is based on the Linux Foundation DANOS project, the first carrier-focused network operating system platform.

DVe is designed with programmability, application awareness, network visibility, and automation built-in to offer operational efficiency and service agility.

DANOS-Vyatta edition has been proven for a number of white box use cases in AT&T's production network. AT&T selected IP Infusion as the exclusive distributor/integrator of DANOS Vyatta edition.

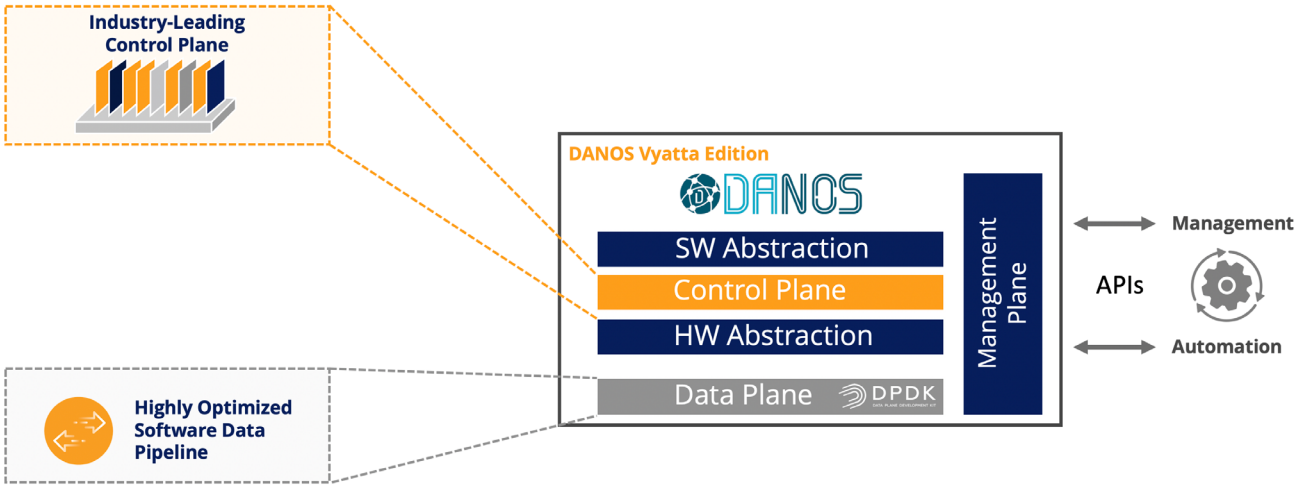

Figure 4: Virtual SD-Edge Secure Virtual Router Architecture

DANOS-Vyatta edition Network Operating System Platform

Key Features	• Ease of installation; designed to be readily automated and orchestrated • Support for standard APIs and data models • Familiar CLI interface • Enables installation of multiple images simultaneously • Image rollback, global config file, etc.
Modular and hardware-agnostic architecture	• Custom packaging that supports diverse deployments • Open APIs enable 3rd-party developer support • Forwarding Abstraction Layer enables seamless support for variety of ODMs • Efficient IPC between feature modules enables scalability and feature velocity
Virtualization ready	• May be installed in public, private clouds, or on bare-metal servers • Capable of both container and VM virtualization • Open architecture built on Linux, DANOS, and other open source • Supports native Linux networking APIs, daemons and tools • DevOps ready, scripting API support

For additional information on DANOS Vyatta edition, visit: https://www.ipinfusion.com/products/danos-vyatta-edition/

High Performance Data Plane Architecture

The dataplane is built on top of DPDK, a widely adopted, open source package that accelerates packet processing for a range of CPU architectures. The Virtual SD-Edge software data plane relies extensively on the Userspace Read-Copy-Update (RCU) mechanism to efficiently share data among virtual cores. Performance is further enhanced by allowing multiple receive and transmit queues to be serviced for the same port simultaneously.

To readily enable integration with multiple switch architectures, the software data plane provides a Forwarding Abstraction Layer (FAL). The FAL employs a plug-in method to abstract data plane processing from the underlying details of the switching architecture and software data plane.

Advanced Networking Features:

IPv4, Ipv6 Routing	• BGP (v4/v6 unicast, vpnv4/6 unicast, 6PE), IS-IS, OSPFv2/OSPFv3, RIPv2/RIPng, Static • Policy Based Routing • Multicast (IGMP, MLD, MSDP, PIM/PIMv6) • BFD
IP Address management	• DHCP/DHCPv6 Client, Server, Relay • Dynamic DNS
L2, Encaps, Tunnels	• Ethernet, 802.1Q, QinQ • Tunnels: GRE, IPSec, L2TPv3, PPPoE • Bridging, Cross-connect, STP/RSTP • LLDP
Monitoring	• TWAMP / IPSLA • Tcpdump, Wireshark Packet Capture • Syslog, SNMP, NTP • SPAN, RSPAN, ERSPAN • Flow Export (IPFIX/sFlow) • VNF probes
Firewall	• Ipv4, Ipv6 packet filter / stateful inspection firewall • Interface based & Zone based • Stateless Packet filtering rules • Stateful firewall and connection tracking • Denial of service (DOS) protection • Control plane protection • Application aware firewall (Deep Packet Inspection) • Session and packet logging
Network Address Translation	• One-to-one; many-to-one; many-to-many; one-to-many • Ipv4 to Ipv4 (DNAT, SNAT, Bidir) • ALGs (FTP, ICMP, ICMPv6, PPTP, RPC, RSH, SIP, TFTP)

Advanced Networking Features (cont'd):

VPN	• Site to Site VPN (IPsec, GRE, VTI) • Multi-site VPN (DMVPN/NHRP)
VRF, MPLS	• VRF-Lite • MPLS LDP, RSVP-TE
Administration	• CLI, Web GUI, RESTful API, Netconf/YANG • Telnet, SSHv2/SSH • RADIUS, TACACS+, OpenLDAP • Role Based Access Control (RBAC) • PXE boot; Cloud-init • Zerotouch Phone Home Client
Virtualization	• Cross-connect and vhost connectivity • Hypervisor (KVM) & Libvirt API modelled in YANG • Cloud-init • VNF probes
QoS	• Traffic matching for QoS with DPI • DSCP classification/remarking • WRR, RED/WRED • Strict Priority Queueing • Bandwidth limits • CPP
High Availability	• Stateful Firewall/NAT failover • VRRPv2/v3, Config synch • Link Aggregation, LACP • ECMP, BFD
Hardware Integration Options	• Unified data plane for Switch Silicon Offload (on supported hardware platforms)

DANOS Open Source NOS

DANOS (Disaggregated Network Operating System) is an open source project hosted by the Linux Foundation that offers an open Network Operating System for disaggregated white box networking devices. AT&T contributed the DANOS code base, which has been adopted by the DANOS-Vyatta edition commercial distribution.

DANOS facilitates rapid evaluation, demonstrations, and DANOS applications qualification. Any updates to the DANOS Core adopted by DANOS-Vyatta edition will be up-streamed to the DANOS code base.

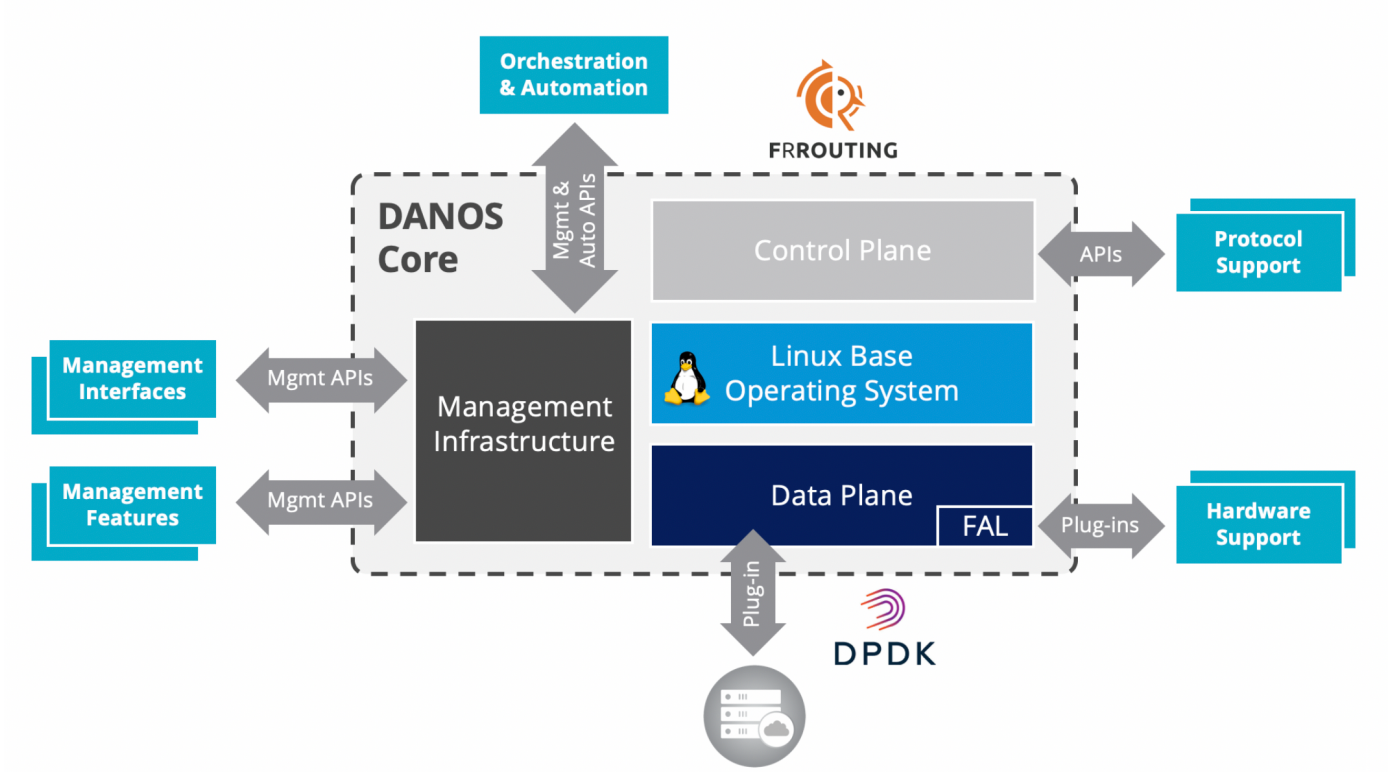

Figure 5: Linux Foundation DANOS Open Source NOS Platform

For additional information on DANOS visit: https://www.danosproject.org/

Virtual SD-Edge Ordering:

The Virtual SD-Edge is available in a virtual-form-factor (VM) for x86-based servers and on public cloud marketplaces.

Users can deploy the Virtual SD-Edge software through a public cloud account (pay-as-you-grow model) or license a VM to run on x86 servers in a private cloud or enterprise networks.

The Virtual SD-Edge VNF model offers simplified licensing – users select the number of virtual cores (1-32) allocated to the VM. By tying licenses to virtual cores and not bandwidth, TCO may be significantly reduced. Subscriptions range from 1, 3, or 5 years, and include IP Infusion's carrier-grade maintenance and support.

Virtual SD-Edge VM SKUs

VIRTUAL SD-EDGE SKU	DESCRIPTION	COMMENTS
DVE-vSDE-BASE-#vCPU-#Y (For deployment)	DANOS Vyatta edition Base VM image with enterprise class networking features such as: Routing (v4/v6), VPN, Firewall, QoS, NAT, WAN optimization, CLI/Netconf/REST API, and Web GUI	• #of virtual cores (1, 2, 4, 8, 16, 32) • #Y: Subscription term is 1, 3 or 5 years • Includes maintenance and support
DVE-vSDE-BASE-T (For trials only)	DANOS Vyatta edition Base VM image with enterprise class networking features such as: Routing (v4/v6), VPN, Firewall, QoS, NAT, WAN optimization, CLI/Netconf/REST API, and Web GUI	• Evaluate on different virtual cores (1, 2, 4, 8, 16, 32) • T: Trial version with a typical 60 day duration

For additional information on IP Infusion's Carrier Grade support, visit: https://www.ipinfusion.com/support/

ABOUT IP INFUSION

IP Infusion, the leader in disaggregated networking solutions, delivers enterprise and carrier-grade software solutions allowing network operators to reduce network costs, increase flexibility, and to deploy new features and services quickly. IP Infusion is headquartered in Santa Clara, Calif., and is a wholly owned and independently operated subsidiary of ACCESS CO., LTD. Additional information can be found at **http://www.ipinfusion.com**

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