ipinfusion™

Product Bulletin

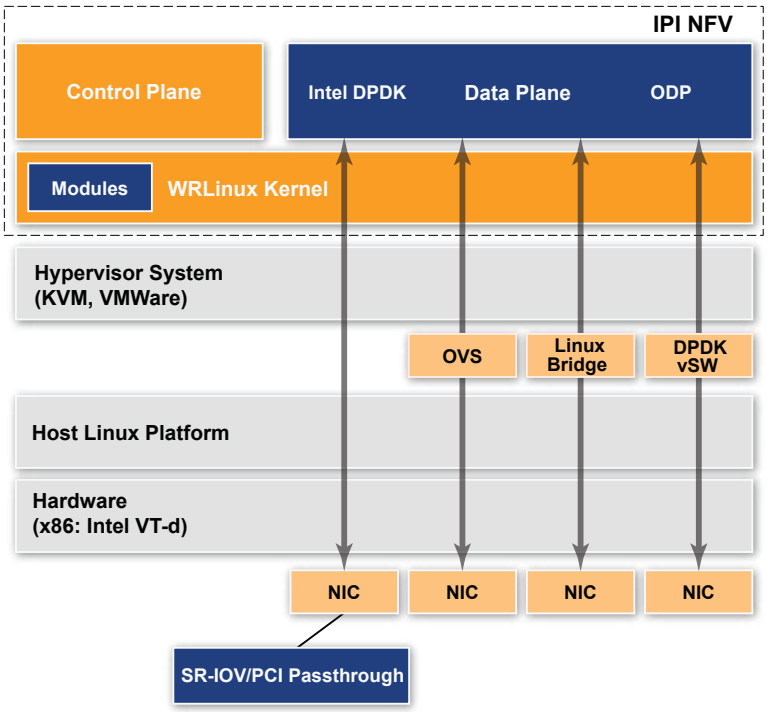
VirNOS™ 2.4

Network operators are facing the increasing challenge of integrating and maintaining a variety of proprietary hardware, compounded with increased energy costs, capital investment and space requirements. Carriers are expected to deliver new revenue-generating services in rapidly evolving markets with reduced time to bring the service to market. At the same time, IT organizations are being asked to deliver new services and functions at increasing speeds and decreasing CapEx and OpEx costs.

Many core networking services including switching, routing, load balancing and VPN can now be performed by software either running directly on x86-64 servers or running as virtual machines, therefore more networking functions are being migrated to standard IT, high-volume server environments. Through Network Functions Virtualization (NFV), network services are virtualized via software, giving network operators a different approach to designing, deploying and managing networking services.

NFV replaces dedicated network hardware with virtualization software running on commodity servers. NFV decouples network functions from proprietary hardware appliances and implements the network functions through software. NFV utilizes standard IT virtualization technologies that run on a range of industry standard, high-volume service, switch and storage hardware to virtualize network functions.

Figure 1. VirNOS Network Configuration



The Data Plane application in IP Infusion's VirNOS supports various network interfaces. In order to achieve the high forwarding performance, IP Infusion's VirNOS supports SR-IOV and PCI passthrough mode with Intel 1/10G Network Interface Cards. In order to achieve flexible service chaining, IP Infusion's VirNOS supports Linux bridging, Open Vswitch bridging and Intel DPDK vSW. Based on the deployment environment, a suitable network interface can be used with IP Infusion's VirNOS.

Addressing Network Challenges

With VirNOS™, IP Infusion provides carriers, service providers, enterprises and network equipment manufacturers a complete NFV-based software package which customers can run, as-is, on top of the standard server platform. IP Infusion customers can integrate VirNOS into their software offering and thereby be able to add services and features more quickly.

VirNOS addresses today's networking challenges with:

- **CAPEX reduction:** Allows for the purchase of commodity servers (standard Intel) instead of purpose-built hardware and supporting pay-as-you grow models.
- **OPEX reduction:** Requires less space, power and cooling requirements and simplifies the launch and management of new network services.
- **Single platform:** Can use a variety of multi-version and multi-tenancy network appliances, allowing use of a single platform for different applications, users and tenants. Resources can be shared across services and different customer bases.
- **Industry proved ZebOS-XP platform:** Leverage matures code base, assuring interoperability with many different existing pieces of network equipment. ZebOS is used by more than 250+ vendors around the world.

IP Infusion's VirNOS is designed to meet the requirements for today's networks via:

- **Flow Switching Support:** Support through OpenFlow to allow for easy deployment of innovative routing and switching protocols in virtual machines, high-security networks and next generation IP-based mobile networks.

Table 1. VirNOS Features

VirNOS Feature	Value to Customers
Supports Network Functions Virtualization	▪ Replaces dedicated network hardware with virtualization software running on commodity servers ▪ Utilizes standard IT virtualization technologies that run on a range of industry standard, high-volume service, switch and storage hardware to virtualize network functions ▪ Consolidates and delivers the networking components needed to support a virtualized network infrastructure ▪ Can select equipment options from multiple vendors instead of buying expensive and restrictive solutions ▪ Reduces CapEx and OpEx costs
Supports Flow Switching via OpenFlow Agent	Can allow the customers to program the Data Plane flexibly by using a general open flow controller
Supports OpenFlow Controller function	Can work along with the existing routing/signaling protocols. Based on the result of the routing/signaling protocols, our OpenFlow controller can convert the routing/signaling information into the flow messages and then program the devices for IPv4, IPv6 and MPLS via OpenFlow protocol.
Supports network interface configurations	Supports several interface configurations to achieve the performance and flexible service chaining with PCI Passthrough, SR-IOV, OpenVswitch Bridging, and Intel DPDK vSW on top of Intel 1G/10G Server NIC.
Supports MPLS	Supports LDP, RSVP-TE and BGP labeled unicast & segment routing.
Supports MPLS L3VPN	Provides support for MPLS based L3 service for both IPv4 and IPv6 applications for both control plane and Data Plane
Supports MPLS L2VPN	Provides support for MPLS based L2 service with LDP signaling with/without the control word.
Leverage Intel DPDK technology (Intel Data Plane Development Kit) to provide a programming framework	▪ Can improve packet processing performance by up to 10G bps per interface ▪ Allows for scaling and faster development of high speed data packet networking applications ▪ Packet processing while executing other workloads on an Intel processor reduced hardware costs, simplifies the application development environment, and reduces time to market
Provides full network connectivity support of IPv4 and IPv6 dynamic routing protocols (BGP, OSPF, ISIS, Static)	Allows a migration path to IPv6, due to IPv4 and IPv6 compatibility
Leverages the mature code base of IP Infusion's industry proven ZebOS-XP® platform which is used by more than 250+ vendors around the world	▪ Assures interoperability with many different existing pieces of network equipment ▪ Vast industry experience and expertise in routing and switching allows IP Infusion to provide custom work for our customers
Supports BFD (Bidirectional Forwarding Detection)	Support for the Global and VRF space and IPv4 and IPv6
Supports OSPFv2 and OSPFv3	Support for both Global and VRF space
Supports 6VPE	Support for IPv6 over MPLS network
Support QoS/ACL	Supporting QoS/ACL for IP/MPLS
Support Flow Conversion	IP/MPLS information can be converted to the flow entries which can be provisioned to the target devices via OpenFlow protocol.
Managed by 3rd party software	Managed by using OpenStack, Ansible.
Customization	Supports a forwarding module defined by user
Flexible performance modes	Supports four different modes to choose between number of CPU cores, memory used versus performance

- Based on the OpenFlow 1.3 specification, VirNOS supports the functionality of both OpenFlow agent, which can be running on the network device, and OpenFlow controller, which can be running outside of the network.
- When using VirNOS as the network device, the existing OpenFlow controller, such as floodlight, opendaylight, etc., can control VirNOS via OpenFlow 1.3.
- If using VirNOS with the OpenFlow controller, VirNOS can provision the flow entries to the network devices. VirNOS can generate the flow entries based on the result of the routing/signaling protocols.

- **Intel DPDK/ODP programming framework:** Compliant to ODP & Intel DPDK programming framework. It enables faster development of high speed data packet networking applications. Developers may be able to eliminate special purpose hardware such as network processors (NPUs), co-processors, application specific integrated circuits (ASICs) and field programmable gate arrays (FPGAs).
- **IPv4/IPv6:** Provides full network connectivity support of IPv4 and IPv6 dynamic routing protocols (BGP, OSPF, ISIS, Unicast). VirNOS supports BGP for IPv4, IPv6, label unicast, OSPFv2, OSPFv3, ISIS (Intermediate System to Intermediate System) for IPv4 and IPv6, and static routing.

- **MPLS:** Provide full network connectivity support of MPLS dynamic signaling protocols (BGP, LDP, RSVPTE, Static). VirNOS supports LSP setup by using LDP, RSVP-TE, BGP label unicast and also supports MPLS L3VPN for IPv4 and IPv6, MPLS L2VPN.
- **Performance:** VirNOS delivers full wire tare (10G bps) with 64+ byte Ethernet frame.

Table 2. VirNOS Functionality

Layer3 functionality of VirNOS support:

- Layer3 switching on the ODP/Intel DPDK
- Routed VLAN on the ODP/Intel DPDK
- VRF (IPv4) Support

Layer2 functionality of VirNOS supports:

- Static ARP
- Bridging
- 802.1Q VLAN tagging
- Layer2 switching

MPLS functionality of VirNOS supports:

- MPLS L3VPN (RFC4364) for IPv4/IPv6
  - Support BGP4+ for PE/PE protocol
  - Support BGP4+, OSPFv2, OSPFv3 for PE/CE protocol
- MPLS L2VPN (RFC4448)
  - Support LDP signaling
  - Support Control word
- LSP setup
  - Support BGP labeled unicast (RFC3107)
  - Support LDP (Label Distribution Protocol) signaling
  - Support RSVP-TE signaling
  - Support Static LSP
- MPLS forwarder
  - Support MPLS L3VPN forwarding for IPv4/IPv6
  - Support MPLS L2VPN forwarding for untag/tagged frame.
  - Support Label Switch forwarding (POP, PUSH, SWAP)

High Availability functionality of VirNOS supports:

- VRRPv2/v3 on Global space for IPv4 and IPv6
- VRRPv2/v3 on VRF space for IPv4 and IPv6

SDN functionality of VirNOS supports:

- VxLAN support
- NvGRE support
- Flow Switching on the ODP/Intel DPDK
- OpenFlow Agent based on OpenFlow1.3
- OpenFlow Controller collaborating with the routing/signaling protocols based on OpenFlow1.3

Network Interface functionality of VirNOS supports:

- Configurable of number of network ports (1 to 15)
- SR-IOV/PCI Passthrough
- Interworking with OpenVswitch

Network monitoring functionality of VirNOS supports:

- sFlow support

Table 3. General Requirements

Virtual Machine

- Supports 1 management interface and 1-15 Data Plane interface
- Support virt-io/e1000 driver for the management interface and e1000 driver for Data Plane interface
- Support SR-IOV, PCI Passthrough, Linux bridge, OpenVswitch bridge, Intel DPDK vSwitch.
- Support Intel 1G/10G Server NIC

Virtual Machine Requirements

- CPU: (# of Data Plane ports + 1) + 2 vcores
- RAM: (# of Data Plane ports + 1) x 1.2 x 2 + 2G Note)
  - (# of Data Plane ports + 1) vcores for Data Plane function.
  - (# of Data Plane ports + 1) x 1.2 x 2 G RAM is for the Data Plane function
  - Additional 2 vcores and 2G RAM for CP/MP functions

Host Machine Requirements

- KVM or VMWare
- Processor
  - Intel VT-x/AMD-V feature
  - More than 4 physical core
- Memory
  - More than 6G RAM
- Network Interface Card
  - Intel 1G/10G Server NIC

Figure 2. VirNOS: Module Overview

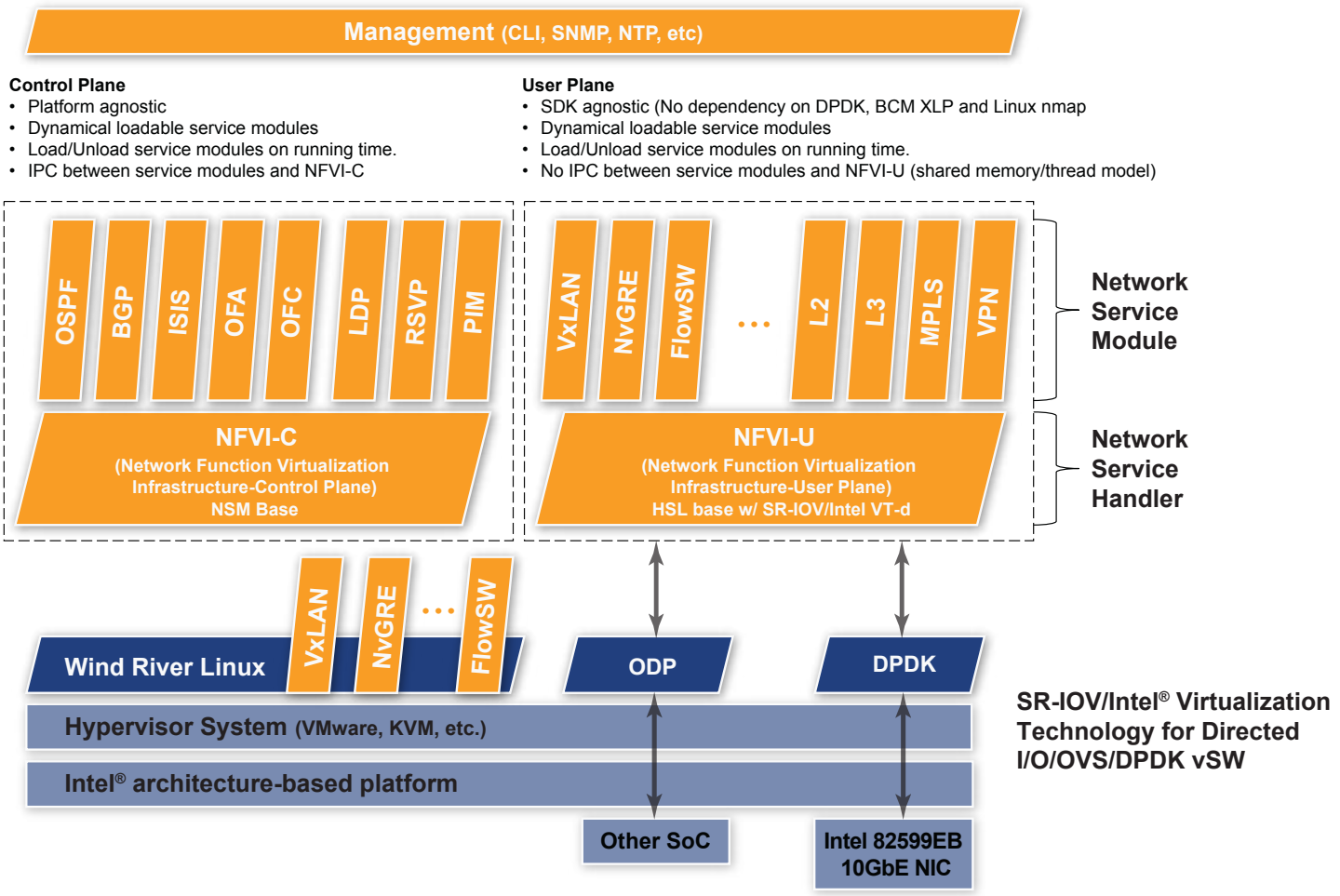
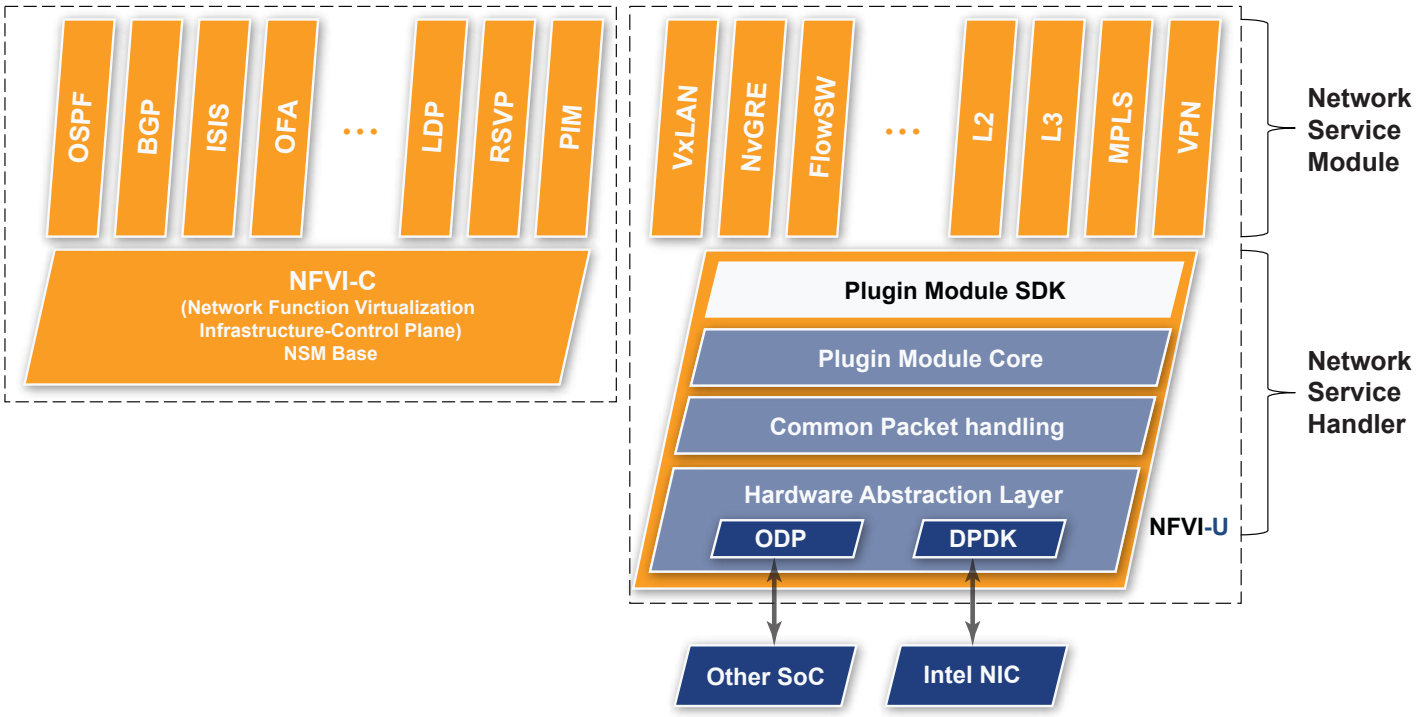


Figure 3. VirNOS: Data Plane Infrastructure



- Each Service Module is the plug-in module for NFV Infrastructure without any dependencies on the hardware SDK (Intel DPDK).
- Each Service Module can be loaded/unloaded dynamically without any impact on other service modules.
- Plugin module will be provided to the customers. The customers can create a new service module based on Plugin Module SDK without any dependencies on the hardware SDK

The customers can create a new service, a new value on top of the existing network.

Table 4. Supported Features (v2.4)

Requirement on Host Machine

- Hypervisor system: KVM
- Memory: more than 6G
- vCPU core: more than 4 cores

Requirement on Virtual Machine

- Memory: (# of Data Plane ports + 1) x 1.2 x 2 + 2 G RAM
- (# of Data Plane ports + 1) x 1.2 x 2 G RAM is for the Data Plane function.
- vCPU core: (# of Data Plane ports + 1) + 2 vCore
- (# of Data Plane ports + 1) vCore is for the Data Plane function.
- NIC driver: virtio or e1000 for management port, e1000 for Data Plane ports

Note

The additional vCore and Memory are needed for the control plane and management plane. Recommended to add 2 vCore and 2G RAM for the control plane and the management plane as shown above.

Network Interface	Management Port	1	Managed by Linux kernel
	Data Plane Port	1-15	Managed by NFVI-U
Layer2	Control Plane	Static ARP	IPv4, IPv6
		Bridge Configuration	
		VLAN Configuration	
	Data Plane	L2 Switching	
		VLAN Switching	
Layer3	Control Plane	BGP4/MP-BGP	IPv4, IPv6, for Global and VRF space IPv4 Labeled Unicast, VPNv4, VPNv6 for Global space
		OSPFv2	For Global and VRF space
		OSPFv3	For Global and VRF space
		ISIS	IPv4, IPv6 for Global space
		Static Route	IPv4, IPv6 for Global and VRF space
		ACL (Filtering)	IPv4, IPv6 for Global and VRF space
	Data Plane	L3 Switching	IPv4, IPv6 for Global and VRF space
		L3 Routed VLAN	IPv4, IPv6 for Global and VRF space
		LAG	For IPv4, IPv6 and MPLS
		QoS	Queuing of IPv4, IPv6 based on DSCP and Marking DSCP
		NAT/NAPT	IPv4 for Global and VRF space
MPLS	Control Plane	LDP	IPv4 for Global space
		MP-BGP	IPv4 Labeled Unicast, VPNv4, VPNv6 for Global space
		MPLS-VPN	IPv4, IPv6
		MPLS-VPN Option.A, B	IPv4, IPv6
		EoMPLS	LDP signaling
		Static LSP	IPv4 for Global space
		Segment Routing	Supporting OSPFv2
	Data Plane	VRF	IPv4, IPv6
		MPLS Forwarding	IPv4 for Global space
		MPLS VPN Forwarding	IPv4, IPv6 for VRF space
		QoS	Queuing based on EXP bits and Marking EXP bits

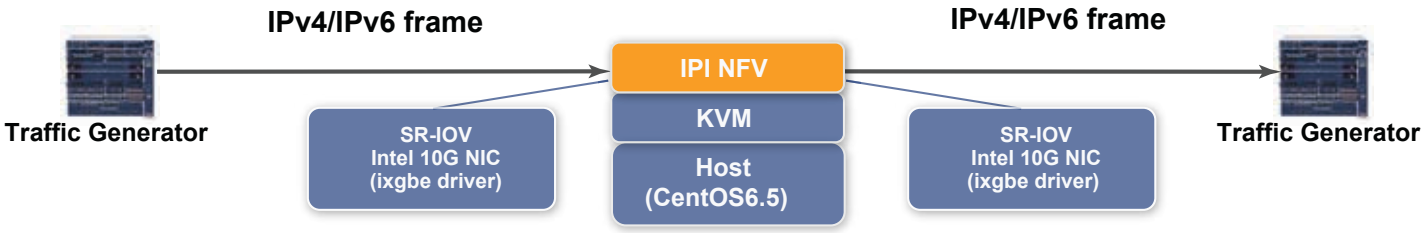
Table 4. Supported Features (v2.4), continued

SDN	Control Plane	OpenFlow Agent	OpenFlow 1.3
		OpenFlow Controller	Working with the routing/signaling protocols based on OpenFlow 1.3
		Circuit Extension	Based on OpenFlow 1.3
	Data Plane	Flow Switching	
		VxLAN	Working with L2 forwarding or Flow Switching
		Inter VXLAN/VPWS bridging	VxLAN/EoMPLS switching based on L3 interface
		NvGRE	Working with L2 forwarding or Flow Switching
Tunneling		GRE	Supporting IPv4, IPv6 on Global and VRF space
		L2TP	Supporting IPv4 on Global and VRF space
Security		IPSec with Software	Supporting IPv4, IPv6, VRF (2.4G bps per CPU core)
		IPSec with Intel QAT	Supporting IPv4, IPv6, VRF (Performance based on the hardware spec)
		IPSec with Intel Multi-Buffer Solution	Supporting IPv4, IPv6, VRF (5.4G bps per CPU core)
		Stateful Firewall	Supporting IPv4, IPv6, VRF
High Availability		VRRP	Supporting IPv4, IPv6, VRF
		BFD	IPv4, IPv6 for Global and VRF space
		Graceful Restart	BGP, OSPF, LDP, RSVP-TE for IPv4, IPv6, MPLS
Monitoring		sFlow	Statistics only
		Process Moniroting	Automatic restart process using software watchdog
		System Monitoring	Zabbix client

Table 5. Supported Management Features

Management feature	Networking	SSH Server/Client	IPv4/IPv6
Management		SSH Server/Client	IPv4/IPv6 on Global space
		Telnet Server/Client	IPv4/IPv6 on Global space
		FTP Server/Client	IPv4/IPv6 on Global space
		SCP Server/Client	IPv4/IPv6 on Global space
		DHCP Server/Client	IPv4/IPv6 on Global space
		DNS Proxy/Client	IPv4/IPv6 on Global space
		NTP	IPv4/IPv6 on Global space
		TACACS+ Client	Global space
		Radius Client	Global space
		Local User Management	—
		Syslog	IPv4/IPv6 on Global space
		SNMPv1/v2/v2c/v3	IPv4/IPv6 on Global space
		Console	
		Command Line Interface	
		Multiple performance mode	Tiny, Low, Middle, High for various data plane performance
	3rd party software	OpenStack (Kilo)	Virtual Router Plug-in API for OpenStack
	3rd party software	Ansible	Auto-configuration from Ansible
Customization		SDK	Support a forwarding module defined by users

Figure 4. IPv4/IPv6 Forwarding Performance



Host Machine Spec:
CPU: Intel® Xeon® CPU E3-1240 @ 3.4GHZ
RAM: 16G
NIC: Intel 82599EB 10 Gigabit SFI/SFP+ (VF)

VM Spec
CPU: 5 vCore
RAM: 8 G
NIC: SR-IOV

Bit rate on IXIA	10 GBPS
Packet size	64 byte
Performance ratio	100 %
IPI NFV Bit Rate	10 GBPS
IPI NFV PPS	14.88MPPS

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About IP Infusion

IP Infusion, the leader in disaggregated networking solutions, delivers the best network OS for white box and network virtualization. IP Infusion offers network operating systems for both physical and virtual networks to carriers, service providers and enterprises to achieve the disaggregated networking model. With the OcNOS™ and VirNOS™ network operating systems, IP Infusion offers a single, unified physical and virtual software solution to deploy new services quickly at reduced cost and with greater flexibility. Over 300 customers worldwide, including major networking equipment manufacturers, use IP Infusion's respected ZebOS platform to build networks to address the evolving needs of cloud, carrier and mobile networking. 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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