vMX Virtual Router

Product Overview

Service providers, cloud operators, and enterprises need highly agile, scalable, and automated networks in order to increase revenue, contain capital spending, and achieve operational excellence. Network Functions Virtualization (NFV), which decouples network functions from service-specific elements so they can run as software on x86 servers, is a critical technology for achieving these goals.

The vMX Virtual Router is a virtualized MX Series 3D Universal Edge Router that helps network operators of all types improve customer experience and profitability by increasing network and service agility and accelerating time to market for new services, while streamlining their operations environment.

Product Description

The Juniper Networks® vMX Virtual Router, available as licensed software for deployment on x86-based servers, Amazon Web Services (AWS), and on the NFX250-S2-R Network Services Platform, supports a broad range of broadband, cloud, cable, mobile, and enterprise applications. The vMX control plane is powered by Juniper Networks Junos® operating system, the same OS that powers the entire Juniper Networks MX Series 3D Universal Edge Routers portfolio, and the forwarding plane is powered by vTrio, Juniper's programmable Trio chipset microcode optimized for execution in x86 environments. With Junos OS and vTrio, the vMX offers advanced routing, quality of service (HQoS), and switching features that ensure the agile and highly efficient delivery of the widest variety of services.

The feature-rich vMX, built on 17 years of Juniper routing investment experience, increases service agility by enabling users to quickly implement and scale services by spinning up new routing instances on demand, and by supporting non-disruptive service introductions in parallel with current services. This approach eliminates the risk, complexity, and delay associated with reconfiguring and requalifying your current infrastructure for new services. Furthermore, the vMX has a granular licensing model that accommodates uncertain forecasts, enabling users to purchase only the amount of capacity they need, reducing the risk of stranded capital.

The vMX also eliminates the cost, complexity, and delay associated with qualifying, maintaining, and sparing physical routing elements. This enables rapid service deployment and scale-out of services, which are critical success factors when expanding into niche markets and new geographies. Importantly, these same attributes help overcome issues related to equipment acquisition for lab trials and release certification.

Importantly, the vMX offers feature consistency with the physical MX Series platforms, including support for high-performance virtual route reflection as well as virtual broadband network gateway (BNG) capabilities, including L2TP network server/Layer 2 Tunneling Protocol (LNS/L2TP), Point-to-Point Protocol over Ethernet (PPPoE), Dynamic Host Configuration Protocol (DHCPv4/DHCPv6), Pseudowire Headend Termination (PWHT) support, and static and dynamic (RADIUS) subscriber interface support. Additionally, a suite of virtualized services are available for the vMX, including IPsec, Layer 7 application awareness, stateful firewall, and carrier-grade Network Address Translation (NAT), which significantly extends the range of applications that the vMX can satisfy. Together, these sophisticated features help service providers implement advanced, virtualized, and distributed architectures that enable the profitable delivery of innovative services in new and traditional markets.
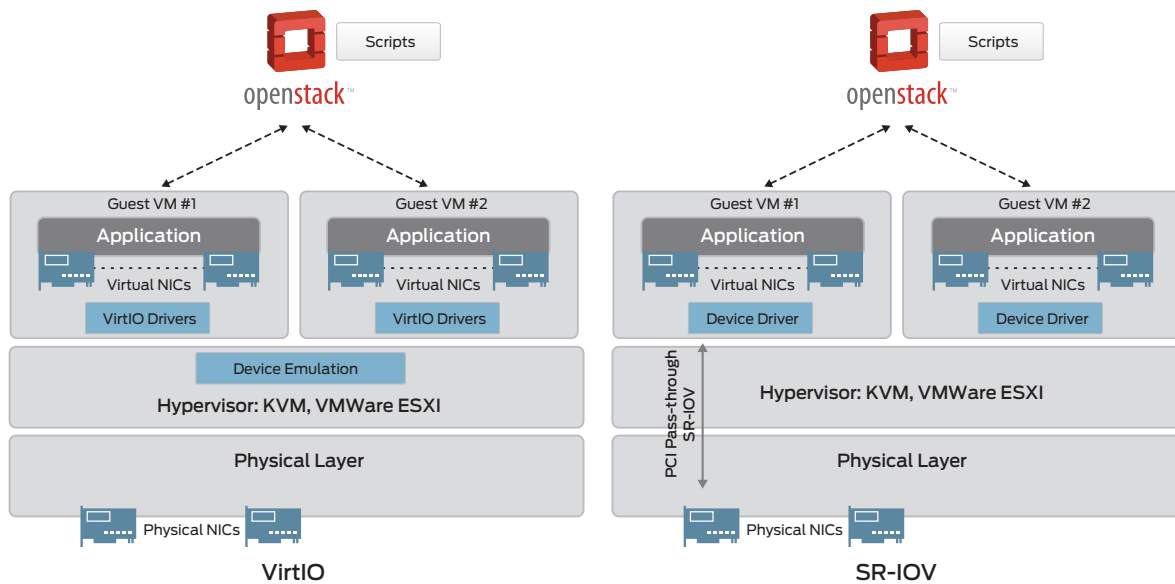
Figure 1: The vMX architecture for VirtIO and SR-IOV.

Architecture and Key Components

The vMX consists of the following:

- Virtual control plane (VCP), which is Junos OS hosted on a virtual machine (VM).

- The virtual forwarding plane (VFP) runs the packet forwarding engine, which is the programmable Trio microcode optimized and compiled for x86 environments. Intel toolkits, including Data Plane Development Kit (DPDK) and Single Root IO Virtualization (SR-IOV), are also employed to further enhance forwarding performance.

OpenStack provides VM management and provisioning of infrastructure network connections, allowing vMX orchestration like any other cloud-based application and enabling customers to nondisruptively add the vMX to their operational environments. Additionally, the vMX is fully integrated with the Juniper Networks Contrail® Cloud Platform™, a turnkey cloud management solution that is hardened with open-source technologies including OpenStack, OpenContrail, Chef, and Puppet.

Features and Benefits

MX Series and vMX: Consistent, Compatible, and Complementary

The vMX utilizes the same Junos operating system and programmable Trio chipset microcode as the physical MX Series portfolio. The vMX and MX Series routers can be selected based on specific goals and objectives without any operational penalty or risk, enabling customers to control the pace of their network evolution without disrupting established operating environments.

MX Series customers can use the vMX to scale out their networks without impacting operations or staff training. Similarly, customers can use the vMX to satisfy immediate needs and adopt MX Series routers for service scale-up at some future point, again without operational disruption.

World-Class Routing for World-Class Networks

The vMX is a true carrier-class router that supports the same broad set of IPv4/IPv6 capabilities available in the MX Series portfolio. This includes comprehensive VPN support at Layer 2 (virtual private LAN service, L2 circuits, L2VPN, and EVPN); Layer 2.5/MPLS (LDP, RSVP, P2MP LDP, and RSVP, with class of service/QoS); Layer 3 (unicast and multicast L3VPNs with CoS/QoS); BNG/LNS; and a variety of multicast techniques (physical interface module, Internet Group Management Protocol, Multicast Listener Discovery, multicast generic routing encapsulation).

Comprehensive BNG Capabilities

The vMX makes an ideal BNG for extending broadband services to residential consumers and extending network access to wholesalers. The extensive suite of BNG feature support includes L2TP network server/Layer 2 Tunneling Protocol (LNS/L2TP), Point-to-Point Protocol over Ethernet (PPPoE), Dynamic Host Configuration Protocol (DHCPv4/v6), Pseudowire Headend Termination (PWHT), static and dynamic (RADIUS) subscriber interfaces, DHCP local server and relay, QinQ, integrated firewall filters, and reverse-path forwarding (RPF) check.

High-Performance Virtual Route Reflection

The vMX also supports virtual route reflection, which is optimized for high scale and performance and offers key features such as route target address family (RFC4684), BGP ADD_PATH, 4 byte Adaptive Services system support, L2VPN address families (RFC4761, RFC6074), and multihop BFD for both BGPv4 and BGPv6. Virtual route reflection helps operators efficiently increase network scale and avoid the cost and complexity of dedicated physical routing platforms.

Improve Control Plane Scale

Edge routers can run out of control plane resources before they run out of forwarding plane resources. The vMX overcomes this issue by allowing independent control plane and forwarding scale, enabling very large forwarding tables and a high number of flows to be supported.

Flexible Implementation Models

The vMX is available as licensed software for x86-based servers and on Amazon Web Services (AWS) Marketplace where it can provide secure routing between AWS virtual path connections (VPCs), private clouds, and on-premises resources. Additionally, AWS customers can bring their own vMX license or take advantage of hourly or annual "pay-as you-go" pricing. The vMX can also be installed on the NFX250-S2-R, enabling customers to deploy a single-vendor hardware/software solution.

Value-Added Service Integration

A suite of licensed virtual services, including IPsec to Layer 7 application awareness (based on deep packet inspection technology), stateful firewall, and carrier-grade NAT, can be optionally added to the vMX. These virtual services broaden the use cases and revenue opportunities that network operators can address while maintaining a single OS for routing and services.

Try Before You Buy

A free 60-day trial makes it easy to evaluate and qualify the vMX in your own network. Visit www.juniper.net/us/en/dm/free-vmx-trial/ to download a vMX trial license. At the end of the trial period, a seamless conversion to purchase process ensures that there is no need to reinstall the vMX. You can also access a free 60-day vMX trial on AWS for the Bring Your Own License (BYOL) model or a free 30-day vMX trial for the Pay As You Go license model.

Low-Risk Market Entry and Expansion

Uncertain forecasts, facility costs, and pressure from incumbents can be formidable barriers to new market entry and geographic expansion. Implementing the vMX in data centers or collocation facilities instead of dedicated telco facilities is an easy and low-risk way to enter new markets and increase or decrease network capacity in response to disparities between forecast and actual service uptake. As demands grow, the vMX is easily scaled up; or conversely, if a service or market underperforms, vMX licenses and servers can be easily redeployed without stranding assets.

Automation and Programmability

Included in Junos OS, the Junos Automation Toolkit is a suite of tools supported on all Juniper Networks switches, routers, and security devices. These tools, which leverage the native XML capabilities of Junos OS, include commit scripts, op scripts, event policies and event scripts, and macros that help automate operational and configuration tasks. Additionally, the Juniper

Extension Toolkit (JET) provides a modern programmable toolkit while maintaining a platform independent architecture, and includes support for:

- OpenConfig/YANG
- gRPC, Thrift, NETCONF
- JSON/XML
- API support for all modern programming languages
- Rich on-box scripting support using Python
- REST APIs

Together, Junos OS automation and programmability features save time by automating operational and configuration tasks, reduce the chance for error, speed troubleshooting, and maximize network uptime by warning operators of potential problems and automatically responding to system events.

vMX Minimum Hardware Requirements

Description	Value
Sample system configuration	For low-bandwidth applications, the minimum CPU requirement is Nehalem Intel processor generation or newer. For high-bandwidth applications, the minimum Intel CPU generation required is Ivy-Bridge Intel processor generation or newer.
Memory	Minimum: 8 GB
Storage	Local or network-attached storage (NAS)
Other requirements	VT-d capability

vMX Minimum Software Requirements

Description	Value
Operating System	Ubuntu 14.04 LTS Linux 3.13.0-32-generic CentOS 7.1 RedHat 7.2
Virtualization	QEMU-KVM 2.0.0 VMware ESXi 5.5/6.0

Dedicated Route Reflector Minimum Hardware Requirements

Description	Value
Sample system configuration	16-core Intel(R) Xeon(R) CPU E5620 @ 2.40 GHz
Memory	Minimum: 16 GB

Dedicated Route Reflector Minimum Software Requirements

Description	Value
Operating System	CentOS 7.1 CentOS 7.2
Virtualization	QEMU-KVM 1.5.3 Libvirt 1.2.8 (CentOS 7.1) QEMU-KVM 1.5.3 Libvirt 1.2.17 (CentOS 7.2) ESXI – 5.5/6.0

Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit www.juniper.net/us/en/products-services.

vMX Ordering Information

Bandwidth-based licenses are available for each application package for the following processing capacity limits: 100, 250, and 500 MB; 1, 5, 10, and 40 GB. Note: For 100, 250, and 500 MB, there is a combined SKU with all applications included.

Product Number	Description
VMX-100M	Perpetual 100 Mbps bandwidth license; supports 50 VPN instances (both L2 and L3 VPN technologies), and 128,000 routing information base (RIB) and forwarding information base (FIB) entries
VMX-250M	Perpetual 250 Mbps bandwidth license; supports 50 VPN instances (both L2 and L3 VPN technologies), and 128,000 RIB and FIB entries
VMX-500M	Perpetual 500 Mbps bandwidth license; supports 50 VPN instances (both L2 and L3 VPN technologies), and 128,000 RIB and FIB entries
VMX-BASE-1G	Base perpetual 1 Gbps bandwidth license; supports 16 L3VPN instances and no other VPN features, and 256,000 RIB and FIB entries
VMX-BASE-5G	Base perpetual 5 Gbps bandwidth license; supports 16 L3VPN instances and no other VPN features, and 256,000 RIB and FIB entries
VMX-BASE-10G	Base perpetual 10 Gbps bandwidth license; supports 16 L3VPN instances and no other VPN features, and 256,000 RIB and FIB entries
VMX-BASE-20G	Base perpetual 20 Gbps bandwidth license; supports 16 L3VPN instances and no other VPN features, and 256,000 RIB and FIB entries
VMX-BASE-40G	Base perpetual 40 Gbps bandwidth license; supports 16 L3VPN instances and no other VPN features, and 256,000 RIB and FIB entries
VMX-ADV-1G	Advanced perpetual 1 Gbps license; supports 1 million RIB entries, 16 L3VPN instances, and 250 VPN instances (both L2 and L3 VPN technologies)
VMX-ADV-5G	Advanced perpetual 5 Gbps bandwidth license; supports 1 million RIB entries, 16 L3VPN instances, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-ADV-10G	Advanced perpetual 10 Gbps bandwidth license; supports 1 million RIB entries, 16 L3VPN instances, and VPN instances (both L2 and L3 VPN technologies) up to system scale

Product Number	Description
VMX-ADV-20G	Advanced perpetual 20 Gbps bandwidth license; supports 1 million RIB entries, 16 L3VPN instances, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-ADV-40G	Advanced perpetual 40 Gbps bandwidth license; supports 1 million RIB entries, 16 L3VPN instances, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-PRM-1G	Premium perpetual 1 Gbps bandwidth license; supports 2 million RIB entries, and 250 VPN instances (both L2 and L3 VPN technologies)
VMX-PRM-5G	Premium perpetual 5 Gbps bandwidth license; supports 2 million RIB entries, and 250 VPN instances (both L2 and L3 VPN technologies)
VMX-PRM-10G	Premium perpetual 10 Gbps bandwidth license; supports 2 million RIB entries, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-PRM-20G	Premium perpetual 20 Gbps bandwidth license; supports 2 million RIB entries, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-PRM-40G	Premium perpetual 40 Gbps bandwidth license; supports 2 million RIB entries, and VPN instances (both L2 and L3 VPN technologies) up to system scale

NFX250 Network Services Platform Ordering Information

The vMX can be implemented on the NFX250-S2-R.

Product Number	Description
NFX250-S2-R	NFX250 for vMX only, 10 10/100/1000BASE-T ports, 2 100/1000BASE-X SFP ports, 2 10GBASE-X SFP+ ports, 6 core x86 processor, 400 GB SSD, 32 GB memory (optics sold separately)

The following bandwidth-based vMX licenses are available for the NFX250-S2-R.

Product Number	Description
VMX-ADV-1G	Advanced perpetual 1 Gbps license; supports 1 million RIB entries, 16 L3VPN instances, and 250 VPN instances (both L2 and L3 VPN technologies)
VMX-ADV-5G	Advanced perpetual 5 Gbps bandwidth license; supports 1 million RIB entries, 16 L3VPN instances, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-ADV-10G	Advanced perpetual 10 Gbps bandwidth license; supports 1 million RIB entries, 16 L3VPN instances, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-ADV-20G	Advanced perpetual 20 Gbps bandwidth license; supports 1 million RIB entries, 16 L3VPN instances, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-PRM-1G	Premium perpetual 1 Gbps bandwidth license; supports 2 million RIB entries, and 250 VPN instances (both L2 and L3 VPN technologies)
VMX-PRM-5G	Premium perpetual 5 Gbps bandwidth license; supports 2 million RIB entries, and 250 VPN instances (both L2 and L3 VPN technologies)

Product Number	Description
VMX-PRM-10G	Premium perpetual 10 Gbps bandwidth license; supports 2 million RIB entries, and VPN instances (both L2 and L3 VPN technologies) up to system scale
VMX-PRM-20G	Premium perpetual 20 Gbps bandwidth license; supports 2 million RIB entries, and VPN instances (both L2 and L3 VPN technologies) up to system scale

Virtual BNG Ordering Information

Using the vMX as a virtual broadband network gateway (BNG) requires a vMX Premium bandwidth license for each virtual BNG instance (1, 5, 10, or 40 GB) and a perpetual or annual Broadband Subscriber Scale license that is applied network wide. Broadband Subscriber Scale licenses are available in packages that support the following specific features.

Package	Description	Potential Use Cases
Introductory	L2TP Introductory features: • L2TP LNS Services • Secure Policy/Lawful Intercept • Service Activation/ Deactivation via RADIUS • Routing Engine-based HTTP Redirect	LNS wholesale (retailer) Business wholesale (LNS) Walled garden (e.g., billing)
Preferred	All Introductory features, plus: • DHCP Subscriber Services • PPP/LAC Subscriber Services • DHCP Relay and Local Server	Residential BBE (PPP, DHCP) Broadband business services L2TP access concentrator (L2TP LAC) (wholesale)
Elite	All Preferred features, plus: • Wireline Policy Management via Gx (PCEF) • Wireline online charging via Gy (PCEF) • Pseudowire Headend Termination	Advanced multicast video IP/MPLS PWHT and subscriber management Fixed/mobile policy convergence

The following table provides a list of Broadband Subscriber Scale licenses.

Product Number	Description
VBNG-INTR-1K	Perpetual Introductory vBNG license for up to 1,000 subscriber sessions
VBNG-INTR-10K	Perpetual Introductory vBNG license for up to 10,000 subscriber sessions
VBNG-INTR-100K	Perpetual Introductory vBNG license for up to 100,000 subscriber sessions
VBNG-INTR-1M	Perpetual Introductory vBNG license for up to 1 million subscriber sessions
VBNG-INTR-1K-1YR	Annual Introductory vBNG license for up to 1,000 subscriber sessions
VBNG-INTR-10K-1YR	Annual Introductory vBNG license for up to 10,000 subscriber sessions
VBNG-INTR-100K-1YR	Annual Introductory vBNG license for up to 100,000 subscriber sessions

Product Number	Description
VBNG-INTR-1M-1YR	Annual Introductory vBNG license for up to 1 million subscriber sessions
VBNG-PREF-1K	Perpetual Preferred vBNG license for up to 1,000 subscriber sessions
VBNG-PREF-10K	Perpetual Preferred vBNG license for up to 10,000 subscriber sessions
VBNG-PREF-100K	Perpetual Preferred vBNG license for up to 100,000 subscriber sessions
VBNG-PREF-1M	Perpetual Preferred vBNG license for up to 1 million subscriber sessions
VBNG-PREF-1K-1YR	Annual Preferred vBNG license for up to 1,000 subscriber sessions
VBNG-PREF-10K-1YR	Annual Preferred vBNG license for up to 10,000 subscriber sessions
VBNG-PREF-100K-1YR	Annual Preferred vBNG license for up to 100,000 subscribers
VBNG-PREF-1M-1YR	Annual Preferred vBNG license for up to 1 million subscribers
VBNG-ELIT-1K	Perpetual Elite vBNG license for up to 1,000 subscriber sessions
VBNG-ELIT-10K	Perpetual Elite vBNG license for up to 10,000 subscriber sessions
VBNG-ELIT-100K	Perpetual Elite vBNG license for up to 100,000 subscriber sessions
VBNG-ELIT-1M	Perpetual Elite vBNG license for up to 1 million subscriber sessions
VBNG-ELIT-1K-1YR	Annual Elite vBNG license for up to 1,000 subscriber sessions
VBNG-ELITE-10K-1YR	Annual Elite vBNG license for up to 10,000 subscriber sessions
VBNG-ELIT-100K-1YR	Annual Elite vBNG license for up to 100,000 subscriber sessions
VBNG-ELIT-1M-1YR	Annual Elite vBNG license for up to 1 million subscriber sessions

Queuing License Ordering Information

The following Queuing Licenses can be added to vMX licenses and vMX virtual BNG licenses

Product Number	Description
VMX-1G-Q	1 Gbps queuing perpetual feature add-on license
VMX-5G-Q	5 Gbps queuing perpetual feature add-on license
VMX-10G-Q	10 Gbps queuing perpetual feature add-on license
VMX-20G-Q	20 Gbps queuing perpetual feature add-on license

Dedicated Virtual Route Reflector Ordering Information

Dedicated vRR licenses are purchased independent of vMX licenses, and are based on control plane scale limits defined by RIB entries.

Product Number	Description
S-VRR-V-S	Small tier perpetual VRR license; supports 4 million RIB entries
S-VRR-V-M	Medium tier perpetual VRR license; supports 10 million RIB entries
S-VRR-V-L	Large tier perpetual VRR license; supports 30 million RIB entries
S-VRR-UPG-SM	Perpetual VRR license to upgrade from small tier license to medium tier license
S-VRR-UPG-ML	Perpetual VRR license to upgrade from medium tier license to large tier license

Product Number	Description
S-VRR-V-S-1Y	Annual VRR license; supports 4 million RIB entries
S-VRR-V-M-1Y	Annual VRR license; supports 10 million RIB entries
S-VRR-V-L-1Y	Annual VRR license; supports 30 million RIB entries
S-VRR-V-S-3Y	Three-year VRR license; supports 4 million RIB entries
S-VRR-V-M-3Y	Three-year VRR license; supports 10 million RIB entries
S-VRR-V-L-3Y	Three-year VRR license; supports 30 million RIB entries

About Juniper Networks

Juniper Networks challenges the status quo with products, solutions and services that transform the economics of networking. Our team co-innovates with customers and partners to deliver automated, scalable and secure networks with agility, performance and value. Additional information can be found at Juniper Networks or connect with Juniper on Twitter and Facebook.

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