SOLUTION BRIEF

Red Hat and Mellanox Deliver Agile NFV Cloud with Unprecedented Performance

Partnership facilitates highly integrated open data path for disaggregated and virtual networks

Executive Summary

Web-scale data centers including public cloud and communication service providers and cloud enterprises are turning towards disaggregation and server virtualization as key tenets to modernize data centers. While each offer benefits of increased efficiencies, flexibility, and agility, they can also impose significant performance penalties by utilizing host CPU cycles for network packet processing. This problem becomes more critical as bandwidth increases to 25/40/50 and 100Gb/s. Additionally, multi-vendor disaggregated software and hardware has been cumbersome to deploy, operate and manage. To properly modernize data centers with disaggregation and virtualization technologies without compromising the performance and operational simplicity, an advanced network infrastructure must be used to boost virtualization efficiencies and support higher rates of packet processing. For these reasons, choosing the right networking hardware becomes critical to achieving an efficient cloud data center vision.

Red Hat and Mellanox Partnership

With more than 20 years of leadership in the open source community, Red Hat delivers technologies that are trusted for their stability, security, and interoperability in enterprise IT environments. These technologies are trusted by 100% of cloud providers in the Fortune Global 500. Red Hat integrates key technologies from open source communities, including OpenStack® and Linux®, into its enterprise-grade products. Mellanox is also a significant contributor to open source communities and has developed a DPDK PMD for ConnectX-5® Intelligent NICs that complement other key features of the adapter for the cloud and service provider market, including Open vSwitch offloads. Both companies continue to provide innovation through ongoing collaboration and contributions to communities that are developing technologies needed in data center to support cloud computing and NFV in the data centers.

Through a long-standing partnership, Mellanox and Red Hat now deliver a highly integrated and open data path for disaggregated virtual networks that eliminate networking and virtualization penalties to deliver unprecedented performance and agility.

Highlights

- Optimization of OpenStack Cloud through Software Accelerators and Hardware Offloads Including:
  - OVS DPDK
  - OVS Hardware Offload with ASAP^2
  - Overlay Networks
  - Stateless Offloads
- Highest DPDK Bare Metal Packet, Rate at Over 148Mpps to Build VNFs
- 55Mpps Through ASAP^2 with Zero CPU Utilization
- Out-of-Box NFV End-to-end Platform
- No Hidden License Fees
- Red Hat Open Source Software Combined with Mellanox's Market Leading High Performance and Efficient Networking Technologies

Addressing the Challenges

To address the challenges of virtualization and disaggregation, Red Hat and Mellanox bring to market a highly efficient, hardware accelerated and tightly integrated cloud data center solution that combines Red Hat Linux OS, Red Hat OpenStack Platform (RHOSP) with Mellanox ConnectX-5® Intelligent network adapters running offload technologies. Rather than employing proprietary tightly-coupled dedicated hardware and software, which tend to be static and difficult to scale, they are replaced with Virtual Machines (VMs) running on commercial off-the-shelf (COTS) servers.

Virtual Network Functions (VNFs) are VMs responsible for handling specialized networking tasks which include features typically performed by switches, routers, and bridges. These often perform actions that require packet forwarding, for example, Network Address Translation (NAT), and Deep Packet Inspection (DPI). Individual virtualized network functions can be chained or combined together to deliver complete networking communication services. However, challenges arise when virtualized network function encounter a high rate of packet processing which is typical in cloud and service provider scenarios. For this reason, DPDK was developed to streamline the forwarding engine (or data plane) of virtualized network functions to increase the rate of packet processing.

DPDK is a set of libraries and drivers that eliminate the processing overhead of needing to wait for interrupts and optimizes buffer management to achieve fast data plane performance. Thus, DPDK significantly reduces the overhead caused by interrupts that are sent each time a new packet arrives for processing.

Open vSwitch Offloads

Open vSwitch (OVS), vRouter, VPP, and Linux Bridge are some of the most popular virtual switch (vSwitch) platforms used in OpenStack cloud deployments today. vSwitches are part of the hypervisor and switch the packets between different VMs on the same host or between VM and the network. Since vSwitch is a software implementation, the packets switching consumes CPU cycles. OVS is a community supported vSwitch with rich networking functions including switching, routing, overlay networking, load balancing, stateful firewall, etc. However, OVS packet performance is very slow. Typically, OVS offers very low packet rate of 500k packets per second using 3 to 4 CPU core. Scaling up the packet rate further consumes a substantial number of CPU cores. Clearly, pure kernel based OVS data path is not efficient and isn't scalable for SDN and NFV transformation. OVS software acceleration and hardware offload techniques substantially improve the traditional slow virtual switch packet performance.

OVS DPDK

DPDK implements a polling process for new packets and the key benefits of significantly improving processing performance while eliminating PCI overhead and maintaining hardware independence. Although DPDK technology consumes CPU cycles,

Mellanox ConnectX-5 Intelligent NICs offer the industry's highest bare metal packet rate of 148 million packets per second for running cloud applications over DPDK. Mellanox actively leads the DPDK software community to drive software innovation. High-performance OVS over DPDK on Mellanox adapters is supported in-box starting RHEL 7.5 and RHOSP 13.

ASAP²

Accelerated Switching and Packet Processing (ASAP²) was developed by Mellanox as an open and high-performance vSwitch or vRouter offload technology. Traditionally, SR-IOV offers a faster data path to virtual machines by virtualizing a physical network adapter PCIe device. However, these faster data speeds are achieved at the expense of software- defined networking (SDN) principles. To solve this challenge, ASAP² offers the best of both worlds: Hardware acceleration through SR-IOV data path (fast-path) for high-throughput flows along with unmodified standard OVS control path for SDN flexibility and programming of match-action rules. ASAP² fully and transparently offloads networking functions such as overlay tunneling, routing, security and load balancing to the Intelligent NIC's embedded switch (e-switch).

As verified during the performance tests conducted in Red Hat's lab, Mellanox ASAP² technology delivered close to 100G line-rate throughput for large VXLAN packet encap/decap without consuming any CPU cycles. ASAP² also boosted vanilla OVS performance by 20x and OVS-DPDK performance by 8x to 55 million packets per second with zero CPU utilization for 64-byte VXLAN packets. Thus, cloud and communications service providers and large enterprises can achieve total infrastructure efficiency from an ASAP² based high-performance solution while freeing up CPU cores for deploying more cloud-native applications and VNFs on the same server and saving capital expenditure. Mellanox ASAP² is fully integrated with RHEL 7.5 and RHOSP 13.

Overlay Networks Stateless Offloads

Overlay networks, such as VXLAN, and NVGRE require an additional header and CRC to accompany the encapsulated data. This results in even more stress being placed on CPU resources as overlay packet formats break traditional TCP/UDP stateless offloads. Mellanox supports overlay network hardware offload that includes stateless offloads such as checksum, RSS, and LRO for VXLAN/NVGRE/GENEVE/MPLS packets.

With VXLAN offload, I/O performance and CPU overhead can be restored to similar levels as VLAN. The results are an increase in server efficiency and more deterministic latency.

Out-of-Box NFV Features

The advanced NFV features of the Mellanox ConnectX family of adapters are designed into the silicon and are fully functional out-of-box with minimal configuration. Other vendors require software development teams with advanced knowledge to integrate NFV best practices into actual solutions, increasing development cost and time to revenue. Mellanox solutions are designed for and tested with standard Red Hat Linux distributions as well CentOS. Offering NFV support out-of-the-box simplifies integration, deployment, and support.

Accelerate Your VNFs with DPDK and Mellanox ASAP²

Mellanox delivers the best DPDK performance in the industry and supports over 148Mpps. To improve upon this, Mellanox offers ASAP² technology which by accelerating packet switching in hardware. The ASAP² accelerates OVS using an embedded network switch to process millions of more packets than DPDK and with nearly zero CPU overhead. This results in the most efficient NFV and SDN solutions.

NFV
Network Function Virtualization

DPDK
DATA PLANE DEVELOPMENT KIT

ASAP²
Accelerated Switching & Packet Processing

DPDK

- Highest Packet Rate
- 50% CapEx Savings
- 66% Lower Latency
- Best in Class Security

ASAP²

- 8X-10X Better DPDK
- Zero CPU Utilization
- Line Rate Performance
- Broadly Integrated

Fig 1. Highest Packet Rate for Bare Metal DPDK VNFs

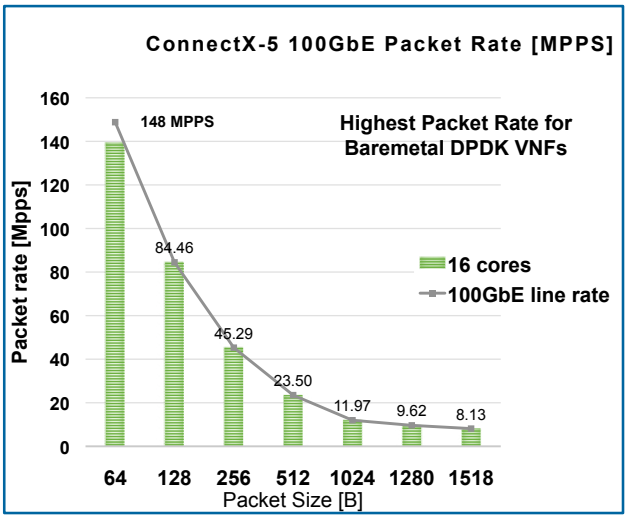
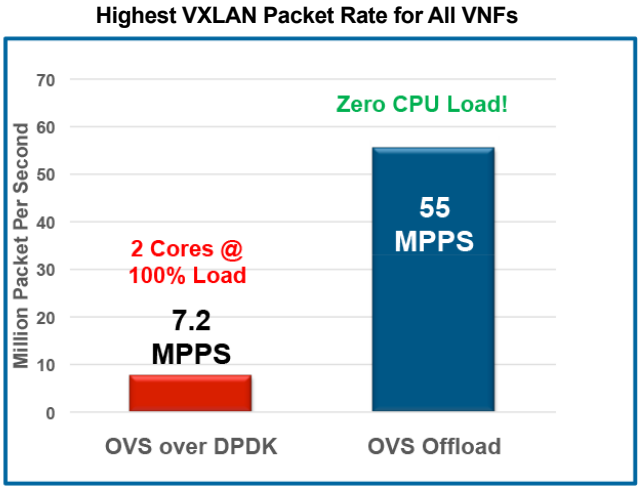


Fig 2. OVS Offload (ASAP²)



Open Ecosystem Collaboration

Mellanox and Red Hat have been collaborating in a number of open source communities to deliver innovative functionality and deliver cloud infrastructure efficiency.

Conclusion

Web-scale and private cloud enterprises are undergoing a major transformation to increase agility and efficiency by introducing virtual networking.

These data center networks need to be much more responsive, efficient and offer agility to rapidly deploy new virtual network services. This must be architected into the network to enable the nimbleness necessary to meet growing demands all while conserving capital expenditure, reducing operating expenses, and accelerating time to delivery. Red Hat and Mellanox offer a tightly integrated Network Function Virtualization Infrastructure (NFVI) and cloud data center solution that removes deployment and interoperability barriers by combining Red Hat open cloud software and Mellanox Intelligent NICs as a joint solution. By offering best of the breed hardware offloads that improve server and network efficiency, performance, and scalability, deployment challenges are addressed for virtual networking workloads.

Red Hat and Mellanox – Datapath Options Support Matrix

Mellanox Adapter	RHEL Ethernet Services	SR-IOV	OVS Fast Datapath Kernel	OVS Hardware Offload	OVS-DPDK (Fast Datapath)	DPDK (RHEL Extras)
	Host Kernel Driver	VF Kernel Driver	Host Kernel Driver	TC/flower Offload	Host DPDK PF PMD	Guest VM DPDK VF PMD
ConnectX-4	RHEL 6.8 RHEL 7.2	RHEL 6.9 RHEL 7.3	RHEL 7.4 (OVS 2.7)	NO SUPPORT	RHEL 7.5 (OVS 2.9 DPDK 17.11)	RHEL 7.5 (DPDK 17.11)
ConnectX-5	RHEL 7.4	RHEL 7.5	(OVS 2.9)	RH OSP13	RH OSP13	RH OSP13

350 Oakmead Parkway, Suite 100
Sunnyvale, CA 94085
Tel: 408-970-3400 • Fax: 408-970-3403
www.mellanox.com

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