Project Summary
OpenNetVM: A Scalable Platform for High Performance Network Function Virtualization
Phil Lopreiato, Tim Wood

Overview

OpenNetVM (ONVM) is a highly efficient network packet processing framework that provides simple abstraction for developing and running network functions. The ONVM platform provides load balancing, flexible packet flow management, individualized service abstractions, and basic software defined networking (SDN) capabilities. The platform already offers best-in-class performance with the ability to maintain 40 Gbps speeds while routing packets through dynamically created chains of network functions and lowers the barriers to deploying production network functions (NFs) in software, all while running on inexpensive commodity hardware. However, this idea can be improved upon: we aim to make it possibly for multiple instances of ONVM to process packets in tandem, with seamless inter-routing, making it possible to run software-based network services at production scale.

Subtopic: Network Function Virtualization
Key Words: networking, software defined networking, packet processing, the cloud

Intellectual Merit:

This Small Business Innovation Research Phase I project will push the limits of the performance possible by commodity servers. OpenNetVM is already a highly optimized platform, and any extensions will need to maintain existing performance standards. One technical challenge will be implementing an intelligent algorithm to discover the optimal node to route a packet that can not be processed locally. The system will need to scale to an arbitrary number of instances of ONVM that can collaborate to process packets in the most efficient way possible, especially if there are multiple possible destinations for a packet. The system needs to keep management overhead minimal and ensure the NF critical path is as fast as possible, because excessive network traffic and computation overhead will degrade the capabilities of the “production” network.

In order to reach these goals, the existing platform needs to be modified slightly to support distributed capabilities. A new abstraction layer needs to be added, so the system can process packets going to and from either local or remote instances of ONVM. This abstraction layer should be generic enough that the two critical paths share as much code as possible and remain highly optimized. Then, a routing protocol that meets the above considerations needs to be designed and implemented. This will necessitate the inclusion of a distributed datastore so that the nodes can share data; this will be a major performance consideration, since the platform can not afford constantly doing slow data lookups.

Broader/Commercial Impact:

This research will drive costs for enterprises building production-scale network services. OpenNetVM can run on cheap commodity hardware, reducing the need to order specialized appliances. For example, using a specially crafted NF running in OpenNetVM, a company can analyze all packets flowing into and out of their network and transparently filter and quarantine malicious traffic without performance degradation. Since the NF is running software, the company does not need to purchase dedicated Intrusion Detection System (IDS) hardware, and malware signatures can be rapidly iterated. Additionally, running all NFs on standard hardware allows users to more efficiently allocate their hardware capacity, all while spending less capital on servers. This project can revolutionize the NFV space, bringing high performance scalable networking applications to commercial applications that could previously not afford such investments and reducing costs for those already using them.

Project Summary (Revised) & Elevator Pitch
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company does not need to purchase dedicated Intrusion Detection System (IDS) hardware, and malware signatures can be rapidly iterated. Additionally, running all NFs on standard hardware allows users to more efficiently allocate their hardware capacity, all while spending less capital on servers. This project can revolutionize the NFV space, bringing high performance scalable networking applications to enterprise consumers at a significantly lower cost.

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OpenNetVM is is intended to benefit enterprise customers. These companies run large-scale, high-perfomance networking applications. These network applications tend to require expensive specialized hardware that can only be purchased from one of few suppliers. For example, a large enterprise typically has an Intrusion Detection System (IDS) protecting the entry point to their network. A popular website or an entry point to the corporate VPN may saturate a 10 Gigabit connection with incoming requests. All of this traffic needs to be screened for malicious traffic. Furthermore, the enterprise may also require a firewall, DDOS detection system, and dynamic routing (like Software Defined Networking); all of these features require different expensive and specialized hardware. So, when building an enterprise-quality network, the infrastructure costs will add up and can quickly become burdensome.

OpenNetVM will allow large enterprises to run their high-performance network applications at a fraction of the cost. OpenNetVM can run on commodity hardware which vastly reduces the amount of capital required to spin up a corporate network. This platform will not sacrifice performance either; packets can be processed at 10 Gigabit speeds, the same speeds as the more expensive dedicated hardware. By utilizing the flexibility of software, OpenNetVM also integrates dynamic network topology. Packets can be routed via a “service chain,” which means a packet flow can be processed by multiple network functions (NFs). This functionality allows the functionality of what would previously require multiple dedicated appliances to be consolidated into a smaller number of commodity servers. Furthermore, as system requirements change over time, the topology of the network function interconnections can be dynamically modified. For example, if the company’s website is experiencing additional load, more instances of a load balancer can be started to accommodate the additional traffic and spread the incoming requests appropriately.

OpenNetVM is able to provide these revolutionary features by implementing Network Function Virtualization (NFV). For every “appliance” that an enterprise IT department would want on their network, they can abstract the functionality into software and run it on the OpenNetVM platform. OpenNetVM uses the high-performance DPDK networking library to interface directly with the hardware. Packets can be shared between NFs and processed without copying overhead – the platform works entirely with shared memory. Furthermore, the OpenNetVM platform will be able to function in a distributed manor: packet flows can be seamlessly routed among multiple hosts to be processed in an optimal way. This means the system can scale seamlessly and automatically recover from failed hosts without loss in service. Automatic failover and horizontal scaling provide features that enterprise customers can rely on in production operations. Traditionally, these features were very expensive to implement, as they require specialized networking hardware. OpenNetVM can provide these advantages for free on inexpensive servers by harnessing the power and flexibility of software.