

WHITE PAPER

Hillstone CloudEdge for
**Network Function
Virtualization
(NFV) Solutions**



Introduction

As technologies have advanced, business applications and operations naturally have become more dynamic in order to adapt. New applications or business operations are created almost every day. In addition to adding new applications, removing or modifying applications and operations happen at a similar speed. However, traditional hardware-based data centers and networks fail to meet the requirements of these highly dynamic environments, as traditional hardware infrastructure cannot be adapted at the same speed as applications.

Thus, virtualization was adopted as the best solution to meet these dynamic requirements. Computing, storage, and network switching are virtualized and provided as virtual services. However, these virtualized elements do not include every component in a data center. In traditional networks and data centers, there are many other devices that run at Layers 3 to 7. These devices include firewalls, routers, load balancers and more, which are necessary and critical for customer experience and security.

In order to virtualize the entire range of network services in a data center, [Network Function Virtualization](#) (NFV) was developed. Under the NFV architecture, **all** network functions (including L3 to L7) are virtualized. In the conversion from traditional physical environments to virtual NFV, many critical issues such as performance, compatibility with various hypervisors, multitenancy support, and elastic management have had to be resolved.

To ensure networking could meet the demands of highly dynamic business operations, data center operators and network service providers needed to adjust their network service alongside customers' virtual machine (VM) or business applications. NFV has become the architecture of choice for these environments by providing an agile, high-performance and responsive architecture that allows rapid adjustment or assignment of resources.

Contents

- Challenges in VNF Implementations 3
 - 3 Automatic Deployment and Configuration
 - 3 Deployment Using an Image or Template
 - 3 Support for Multiple Cloud Platforms
 - 4 Embedded Automatic Configuration
 - 4 Scalability and Elasticity
 - 4 Open API and Software Orchestration
- VNF Solution from Hillstone Networks 5
 - 5 Hillstone VNF is Highly Compatible
 - 6 Automatic Deployment and Initial Configuration
 - 6 Automatic License Management
 - 6 Elasticity and High Performance
- REST API 7
 - 8 NFV Orchestration
 - 8 Orchestration Based on Cloud Platform
 - 9 Orchestration Based on OpenStack FWaaS Plugin
 - 9 Orchestration Based on Open-Source MANO
- Customer Success Stories 11
 - 11 Use case 1: Protecting North-South Traffic on a Cloud Platform
 - 11 Use case 2: Orchestration through Heat
 - 11 Use case 3: Replace vrouter in OpenStack Deployment
 - 11 Use case 4: Replacing OpenStack Native Firewall
- Conclusion 12

A Virtualized Network Function (VNF) is the basic building block in the NFV architecture and is essentially a software implementation of a given network function. When router, firewall, IPS and WAF devices are virtualized, for example, they become VNFs. As a security solution provider, Hillstone Networks is actively working to provide VNF solutions for NFV deployments.

This white paper provides an in-depth discussion of challenges in choosing and deploying a VNF module in an NFV architecture, as well as VNF solutions from Hillstone Networks.

Challenges in VNF Implementations

The major functional differences between traditional network functions and virtualized network functions reside in the following areas:

- Self-service
- Self-configuration
- Elasticity

In addition, virtualized functions must provide a north-bound API to integrate into higher level management and orchestration software (MANO). Some of the key features required by NFV architectures for VNFs are discussed in the following sections.

Automatic Deployment and Configuration

Automatic deployment and configuration are necessary to enable and support self-service and self-management. Without the intervention of data center administrators, customers or tenants should be able to achieve

self-service and self-management, similar to the services provided by public clouds such as AWS, Azure, or other cloud providers.

Deployment Using an Image or Template

As a part of self-service deployment, a VNF must provide a VM image or deployment templates to allow rapid implementation when customers need to start a new service quickly to address a business demand.

Support for Multiple Cloud Platforms

Hybrid-cloud and heterogeneous-cloud services will be used by businesses for the foreseeable future. On the management side, cloud management platforms are capable of managing multiple cloud platforms. For example, one management platform can manage a VMware data center, an OpenStack data center, and AWS as well. To provide a single solution to a cloud operator,

a VNF must also support multiple cloud platforms, which usually include VMware, OpenStack, AWS, Azure, Ali Cloud, and others.

Embedded Automatic Configuration

If a VNF is deployed through a single VM image or template, multiple instances can contain the same configurations (such as interface IP, route, username, or password). This makes the instances unusable by multiple customers or tenants, and thus it is necessary to automatically customize certain configurations after a VNF is deployed.

There are multiple approaches to implement an automatic configuration, like updating the configuration file before the VNF boots up, embedding a startup agent (VMware and Azure), or reading a user-specific configuration (AWS and OpenStack) during boot-up.

Scalability and Elasticity

Since business applications and operations change over time through expansion or reduction, services provided by VNFs must scale up or down as necessary. To provide this scalability, a VNF needs to provide overall performance scaling by adjusting virtual resources (virtual CPU and memory), instead of redeploying the entire VNF. Similar performance scalability requirements are also applied for VNF network interfaces, which need to support Single Root I/O Virtualization (SR-IOV) and hot plug-and-play.

If certain features or the performance of a VNF are controlled by a license, license management must be scalable as well; otherwise, it can block performance scaling.

Open API and Software Orchestration

In the NFV architecture, a VNF module is managed by other orchestration software. The orchestration software can be NFV Management and Orchestration (MANO) software or a VNF Manager (VNFM). Available orchestration software includes OPEN-O, OSM, Tacker, and others. (Since Software Defined Networking, or SDN, does not follow the standard defined by European Telecommunications Standards Institute (ETSI), it is not classified as NFV orchestration software.)

The management software is capable of orchestrating multiple types and instances of NFV modules through a centralized console. It not only supports the daily operations of a cloud administrator, but also implements service chains and ensures continuous deployment and upgrades.

Since the orchestration software needs to configure a VNF and manage its execution, the VNF needs to provide a northbound interface, like SOAP, XML or REST API.

VNF Solution from Hillstone Networks

The goal of NFV is to improve the efficiency of deploying new services and adjusting existing services to meet the demands of highly dynamic business operations. Compatibility, elasticity, high performance, and an open API are all crucial to an NFV solution.

In addition to the above features, automatic orchestration and license management are also key functions in the service orchestration process. Orchestration ensures each VNF module can be deployed and configured automatically, including initial and customized configuration based on each specific service. License management ensures VNF modules can automatically

enter operation mode. Hillstone NFV solutions address these requirements as discussed in the following sections.

Hillstone VNF is Highly Compatible

Hillstone provides a highly compatible virtual firewall, which can support four major hypervisors: ESXi, KVM, Hyper-V, and Xen server. Hillstone’s VNF solution also supports multiple cloud platforms, including VMware, OpenStack, Huawei, ZTE, Inspur and Array Networks. It has been integrated into cloud solutions from multiple public cloud providers, like AWS, Azure, and Ali Cloud, HUAWEI and Tencent Cloud.



Figure 1: Partners and compatible cloud providers

Automatic Deployment and Initial Configuration

To support different cloud platforms, Hillstone provides multiple formats of VNF images (ova, vhd, qcow2) to meet various customer requirements. Virtual resources for Hillstone's virtual firewall have been pre-configured to ensure a fast and successful deployment.

An embedded agent is used to retrieve the initial configuration during the boot-up process to customize each VNF module based on customer requirements. Hillstone has integrated vmttools, cloud-init, and the Qemu Guest Agent into the VNF module. With embedded agents, the interface IP, route, username, and password can be injected into the VNF during the module boot-up process.

Automatic License Management

After the automatic deployment and initial configuration is complete, the VNF module is not yet fully functional because its features are also controlled via a license. To ensure VNF modules can closely follow user requirements to start, adjust, or shut down, license management also needs to implement automatic dispatch and recycle mechanisms.

Hillstone offers the License Management System (LMS) to provide a license management solution for VNF deployments. When a Hillstone VNF module requires a license during start-up, it will connect to the LMS, which can assign certain licenses to the module based on pre-configured rules. When a VNF's configuration needs to be adjusted to meet user requirements, it can get updated licenses from the LMS. When a VNF completes

its service and is being terminated, LMS can recycle its licenses. The licenses can subsequently be reassigned to other VNF modules.

With the help of LMS, licenses are automatically assigned or recycled whenever a VNF module starts, adjusts, or terminates. This helps ensure that network services scale along with customer requirements.

Elasticity and High Performance

Besides scaling out by automatically deploying more VNF modules, a single VNF module is also capable of scaling up to meet requirements based on network topology changes and performance needs. When new virtual networks are created based on a business need, a single VNF module can provide more network interfaces at run-time to connect to newly created VM virtual networks.

Hillstone VNF can also automatically adjust virtual resources as needed. Without re-deploying the VNF module, new resources (vCPU and memory) can be assigned and a new license with higher capacity loaded via the LMS.

Increasing virtual resources (like vCPU and memory) can help to increase VNF performance to a certain extent. When this approach reaches its limit, a VNF can enable the support of SR-IOV and further improve the interface throughput to nearly line rate.

REST API

Customers typically need to manage multiple types of network services from cloud platforms to fulfill business requirements. To improve the user experience and reduce operational complexity, cloud service providers usually provide a single management portal and integrate management and configuration of multiple virtual services and resources on that portal. To be managed and configured by the management portal, the VNF module must provide a northbound interface to the upper-level management software. Thus, a cloud user can manage all services from a single portal.

REST API is a popular interface standard, and major cloud management platforms (like AWS, Azure,

and OpenStack) support it. To integrate with a cloud management platform or other types of management software, Hillstone VNF provides a REST API for module management and service configuration. Through REST API, cloud service providers can push configurations to VNF modules and provide a self-management service to cloud users through its management portal.

Currently, Hillstone VNF REST API supports system configuration, security policy configuration, interfaces and network configurations. Figure 2 shows a portion of the Hillstone VNF REST API specification.

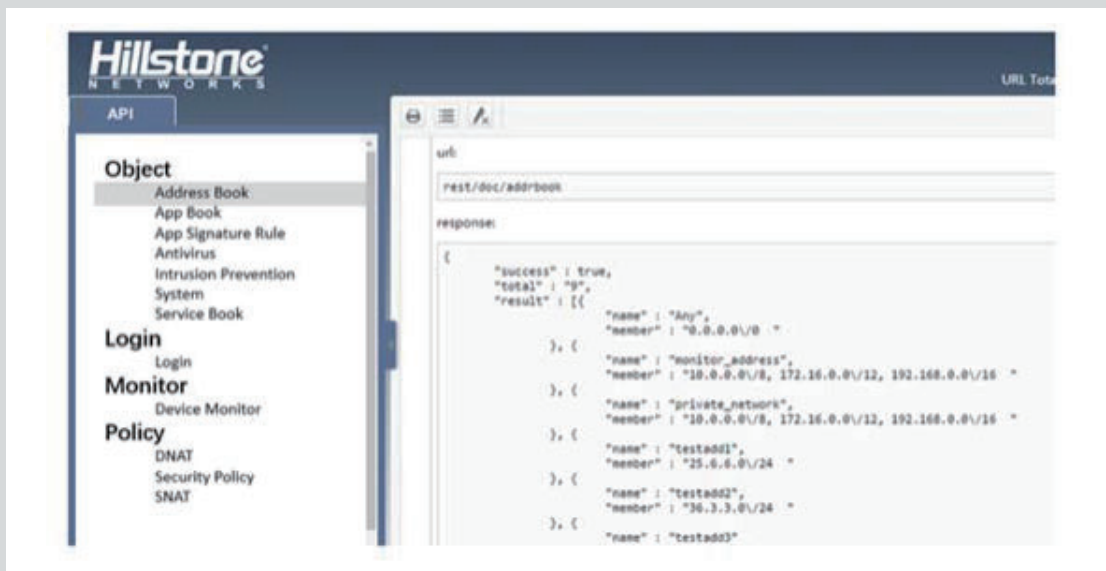


Figure 2. Hillstone VNF REST API specification

NFV Orchestration

In the standard NFV framework from ETSI, the NFV Orchestrator uses the VNF Manager (VNFM) to orchestrate VNF services. VNFM uses info from the VNF Descriptor to request resources from the Virtualized Infrastructure Manager, deploy VNFs, and manage virtual networks. Figure 3 shows the standard ETSI NFV framework.

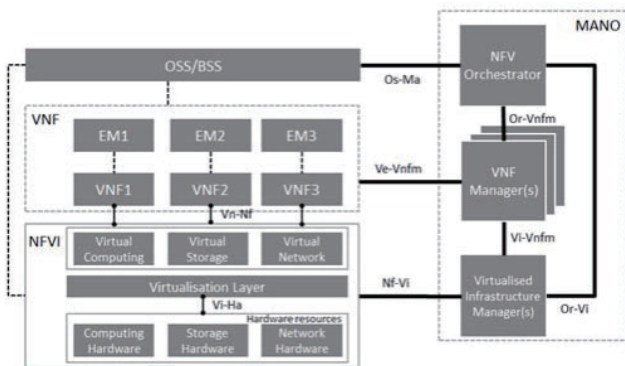


Figure 3. ETSI NFV framework

However, in real-world customer environments, because of the differences in underlying technologies and levels of operation, cloud infrastructures may not strictly follow the above NFV framework. To best fit into customers' environments and reduce challenges in deployment and integration, Hillstone provides three types of NFV orchestration solutions, outlined herewithin.

Orchestration Based on Cloud Platform

In this approach, Hillstone VNF integrates with a cloud platform or cloud management platform. With minor integration efforts, cloud operators can manage and configure Hillstone VNF from existing management frameworks.

Hillstone provides multiple types of VM images to support different types of hypervisors, the LMS to support automatic license management, and an embedded agent to support automatic customized configurations. Hillstone also provides a management agent that can integrate with a cloud management platform and provide an API interface for advanced integration.

Hillstone VNF has been orchestrated by vCenter and OpenStack with this approach, and also integrated with 3rd party cloud platforms through a similar approach. For example, Hillstone VNF has been integrated into HUAWEI cloud orchestration, and allows the HUAWEI cloud to manage VNF life cycle and configuration.

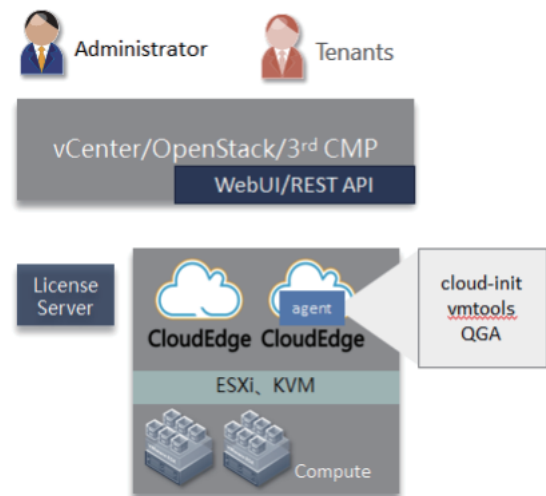


Figure 4. Orchestration based on cloud platform.

Orchestration Based on OpenStack FWaaS Plugin

Hillstone VNF module can be integrated with and managed by the OpenStack Firewall as a Service (FWaaS) plugin. In this solution, Hillstone Networks provides a virtual Service Orchestration Module (vSOM) component. Under an OpenStack deployment, Hillstone Networks L3-agent or FWaaS-driver, or a vSOM can initiate a Hillstone VNF module to act as the vrouter or firewall to replace the OpenStack-native vrouter or iptables-based firewall.

With this approach, the workflows of vrouter and FWaaS creation remain the same and can be managed from the native OpenStack management portal, called Horizon. Hillstone VNF achieves seamless integration with OpenStack through minimum change on the OpenStack management platform. Figure 5 shows the framework for this integration approach.

Orchestration Based on Open-Source MANO

Multiple open-source MANO solutions (such as OPEN-O, OSM, and Tacker) are available in the market. By using an open-source MANO solution, cloud service providers can implement more flexible orchestration solutions. They can also do further development to meet the needs of their business or customers.

Topology and Orchestration Specification for Cloud Applications (TOSCA) is an OASIS standard language used to describe a topology of cloud-based web services, their components, relationships, and the processes that manage them. Many NFV/VNF vendors follow and use TOSCA to describe and specify a Virtual Network Function Descriptor (VNFD). Specified with TOSCA and working with open-source MANO, VNFD orchestrates service modules from disparate vendors. This approach ensures NFV services from different vendors are fully decoupled.

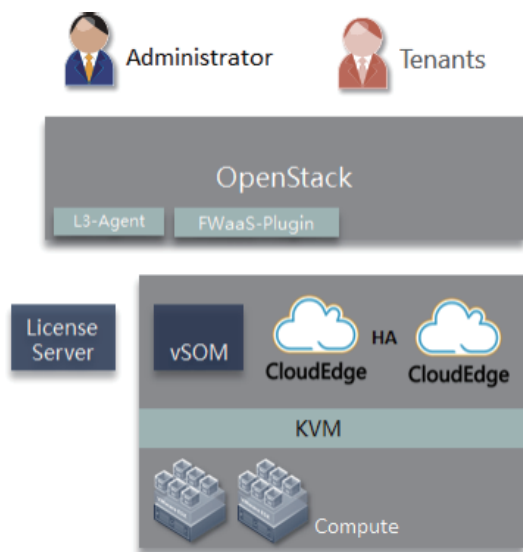


Figure 5. Orchestration based on OpenStack FWaaS.

```

VNFD Template
tosca_definitions_version: tosca_simple_profile_for_nfv_1_0_0
description: waf example
metadata:
  template_name: sample-tosca-vnfd
topology_template:
  node_templates:
    VDU1:
      type: tosca.nodes.nfv.VDU.Tacker
      properties:
        image: vfw
        flavor: vfw
        availability_zone: nova
        mgmt_driver: noop
        config: |
          user_data_format: RAW
          user_data: |
            #cloud-config
            chpasswd:
              list:
                hillstone: Hillstone@123
            runcmd:
              - ips sigset waf_http template http
              - web-server default
              - sql-injection-check enable sensitive low action log-only
  groups:
    VNFFG1:
      description: EXT to WEB
      members:
        - Forwarding_path1
      properties:
        connection_point:
          - CP11
          - CP21
        constituent_vnfs:
          - waf
          - s1b
        dependent_virtual_link:
          - VL11
          - VL21
        number_of_endpoints: 5
        vendor: tacker
        version: 1.0
      type: tosca.groups.nfv.VNFFG
      node_templates:
        Forwarding_path1:
          description: creates path (gateway->waf->s1b->servers)
          properties:
  
```

Figure 6. Hillstone VNF VNFD and VNFFGD template samples

Hillstone provides a TOSCA-based VNFD template for its VNF module. Through the orchestration of open-source MANO, Hillstone VNF can be deployed as a standalone module, as a pair for high availability, or as a single module in Service Function Chaining (SFC). This approach follows ETSI standards and is the ideal solution for NFV orchestration.

Figure 6 shows portions of Hillstone VNFD and VNFFGD (VNF Forwarding Graph Descriptor).

Figure 7 shows the block diagram of orchestration based on an open-source MANO.

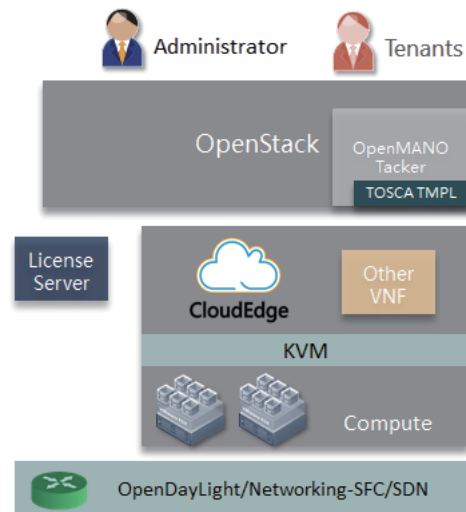


Figure 7. Orchestration based on an open-source MANO

Customer Success Stories

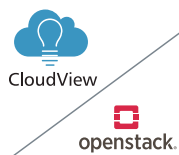
CloudEdge is Hillstone's virtual firewall VNF solution for NFV deployment. Hillstone Networks has a long-standing and extensive partnership with cloud service

providers in developing and enhancing this solution. Real-world customer deployments and Proof of Concept (PoC) cases are described in the following sections:



Use case 1: Protecting North-South Traffic on a Cloud Platform

A major cloud service provider integrates Hillstone CloudEdge with embedded vmtools into its cloud platform. Through CloudEdge's REST API, the cloud management platform integrates the CloudEdge security policy configuration into its existing management user interface and provides unified management to its customers. From the cloud provider's management portal, customers can configure and apply NAT rules, security policies, and access control rules to Hillstone CloudEdge.



Use case 2: Orchestration through Heat

An OpenStack integrator and OpenStack Gold Member integrates Hillstone CloudEdge with embedded cloud-init into its OpenStack solution. The CloudEdge image is initiated through a Heat template and customized configurations are sent to CloudEdge through the REST API.



Use case 3: Replace vrouter in OpenStack Deployment

In a vertical cloud designed for a province in China, the cloud service provider integrates Hillstone CloudEdge through an OpenStack FWaaS plugin. Hillstone Networks L3-agent converts firewall policies received from the cloud management platform to the Hillstone policy format, and pushes the policies into the CloudEdge module. When a user or tenant creates a new Layer 3 network on the cloud management platform, the Hillstone CloudEdge is automatically created or configured to act as a vrouter for the network.



Use case 4: Replacing OpenStack Native Firewall

A tier one Telco is designing an internal data center based on an NFV architecture. OpenStack was chosen as the VIM. Their home-grown orchestration software manages both SDN and Hillstone CloudEdge modules. Hillstone CloudEdge is used to replace the OpenStack native firewall. Hillstone Networks FWaaS driver is used to achieve automatic deployment, convert FWaaS policy to the Hillstone policy format, and build service chains along with the SDN controller.

Conclusion

NFV is a popular choice in the path of transforming traditional networks to virtualized networks. Both traditional network device vendors and traditional network service providers are starting to upgrade or converge to NFV. A complete NFV solution requires deploying multiple types and instances of VNF modules. This type of deployment is typically complex and requires completely automatic orchestration support.

Hillstone Networks has been actively working in the area of cloud computing for many years. Hillstone CloudEdge provides multiple integration solutions for

various cloud platforms and has been deployed in multiple test and production cloud environments to serve a wide variety of industries and customer requirements. Hillstone will continue to invest in cloud computing and develop solutions for hybrid-cloud and heterogeneous clouds, to continue to deliver ever more flexible, user-friendly, and robust solutions to the market.

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Visit www.hillstonenet.com to learn more
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