

## VMware

**Benu Networks' mission is to help fixed and mobile broadband operators transform the edge of their IP networks into a next generation service edge that can move from beyond providing transport services, enabling the ability to offer differentiated services. Benu Networks' next generation Virtual Service Edge (VSE) platform provides a new class of subscriber management, scalability, and intelligence that bridges the service edge to the service cloud. Benu Networks' VSE platform leverages VMware ESXi technology to deliver best-in-class data plane and control plane functions.**



### USE CASES

- Managed Business Networking – Enterprise Virtual Customer Premises Equipment (Enterprise vCPE)
- Managed Home Networking – Residential Virtual Customer Premises Equipment (Residential vCPE)
- Large-scale Community Wi-Fi for Business, Residential, and Outdoor Coverage with Cellular Off-load
- Wholesale Wi-Fi Roaming and Cellular Mobile Data Offload
- Cellular Mobile Data Interworking
- Vanity SSID and Managed Wi-Fi Services
- IPv4-IPv6 Dual-Stack (DS-Lite) Solution

### KEY FEATURES AND BENEFITS

- Device, group or network (private, public, guest) contextual policy enforcement per device, group or network slice
- Contextual policies support restricted access based on time, schedule, or location, etc.
- Network-based policies enforcement such as bandwidth limits, number of devices, ACLs, and application
- Security-based policies for enforcement of device, and device behavior
- Frictionless on-boarding of devices with fingerprinting and analytics
- Service steering and cloud-service interaction leveraging open standards (e.g. service function chaining, OpenFlow)
- Mobility of service delivery, and contextual, or network-based policies across Wi-Fi, Cellular, and Fixed Network Access
- Real-time programmable policy control and OSS/BSS integration via north bound APIs

### KEY CHALLENGES

The current architecture of an embedded Router (eRouter) and the Wi-Fi gateway on the customer premise presents a number of challenges for fixed operators.

Since the eRouter is a network address translation (NAT) function, the operator can't see or influence the behavior of delivering service to the connected IP devices behind the NAT. The current architecture places the eRouter/NAT as the first IP hop which does not provide any visibility to the connected devices.

The lack of device visibility beyond the customer premises equipment (CPE) limits the operator's ability to support network connectivity issues particularly if the CPE is providing an embedded Wi-Fi Router functionality. This impedes the operator's capability to resolve device connectivity issues which increases the demand on customer care resources and can result in costly truck rolls. The ability to deliver an optimal quality of experience (QoE) to end-user devices is not possible.

Currently, operators are not able to offer per device value-added services to subscribers, such as parental controls, advanced security, and Internet of Things (IoT) management, that are competitive to over-the-top (OTT) solutions, or are cost prohibitive to offer. All changes required at the network protocol layers in the CPE will take an operator a substantial amount of time to coordinate between multiple CPE vendors and may also limit functionality.

To be competitive, operators must become “more nimble” and have the ability to rapidly create new services in the same manner as OTT vendors. This will allow them to compete by rapidly rolling out advanced features that are independent of the CPE, and highly desired by customers. This empowers operators to be independent of their many CPE vendors, and completely eliminate the very long CPE upgrade and qualification timeframes.

A new, next generation architecture is needed that leverages the operator’s existing assets in both the access and core network. The new architecture needs to move the IP network logic or service logic that is locked in the CPE’s Wi-Fi access point/Router to the service aware edge cloud, Benu Networks’ Virtual Service Edge (VSE) platform achieves this by virtualizing the eRouter function in a multi-tenant virtualization platform that has been designed to aggregate tens of thousands of virtual CPE/routers. Commonly known as a virtual CPE (vCPE) architecture, the VSE simplifies the physical CPE by leveraging two virtualization concepts: dynamic soft-wire tunnels (overlay) to transport layer 2 (Ethernet) traffic from the physical CPE, and network function virtualization of the eRouter. The Layer 2 Ethernet traffic is bridged over the generic Router Encapsulation (EoGRE) transport, L2TPv3, or IPsec to move the first IP hop to the edge cloud. Local traffic in the home or business LAN stays local.

## SOLUTION OVERVIEW

Benu Networks’ Virtual Service Edge (VSE) platform in an innovative solution, which:

- Leverages service overlays to aggregate device sessions from the access network
- Implements virtualization of the business or home router functions needed to enforce device level policies
- Provides granular subscriber management and traffic control of sessions
- Facilitates mobility and service edge routing to interconnect to the IP backbone or Internet offload

Benu Networks’ VSE provides a virtualization framework to deliver flexible scalability of subscribers and per-device session delivery. The VSE virtualized functions are assembled into a set of operator service domains to enable multiple virtual network slices such as vCPE and Wi-Fi access gateway (vWAG) use cases on a single platform. All network functions are highly programmable via a REST API, and support service function chaining (SFC) to integrate value-added service functions on a per-subscriber basis.

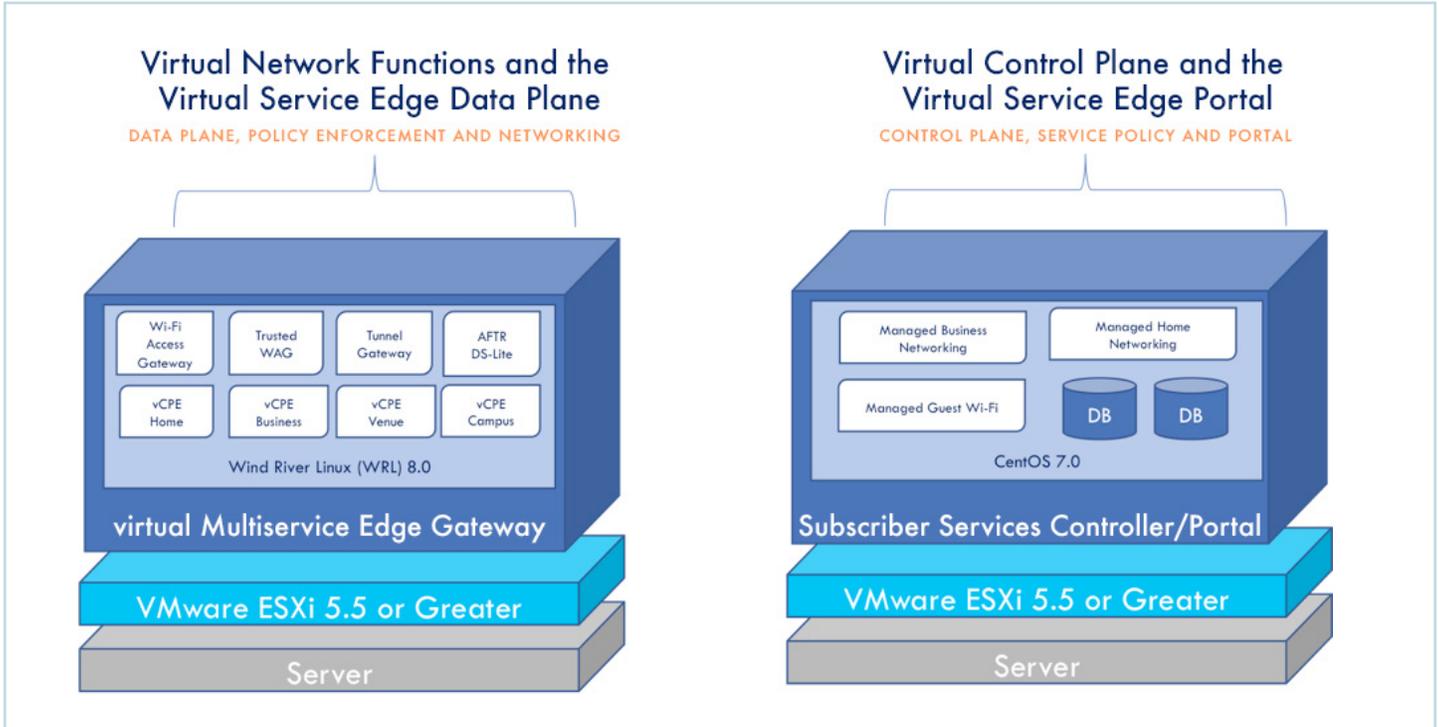
Benu Networks’ VSE leverages VMware’s technology to deliver best-in-class data plane performance, service agility, and network topology flexibility. VMware provides a carrier-class network functions virtualization infrastructure (NFVI) environment with the reliability and predictability necessary for mission critical network function operations.

## VIRTUAL NETWORK FUNCTIONS ON VMware

Benu Networks’ Virtual Network Functions (VNFs) on VMware comprise of 2 components.

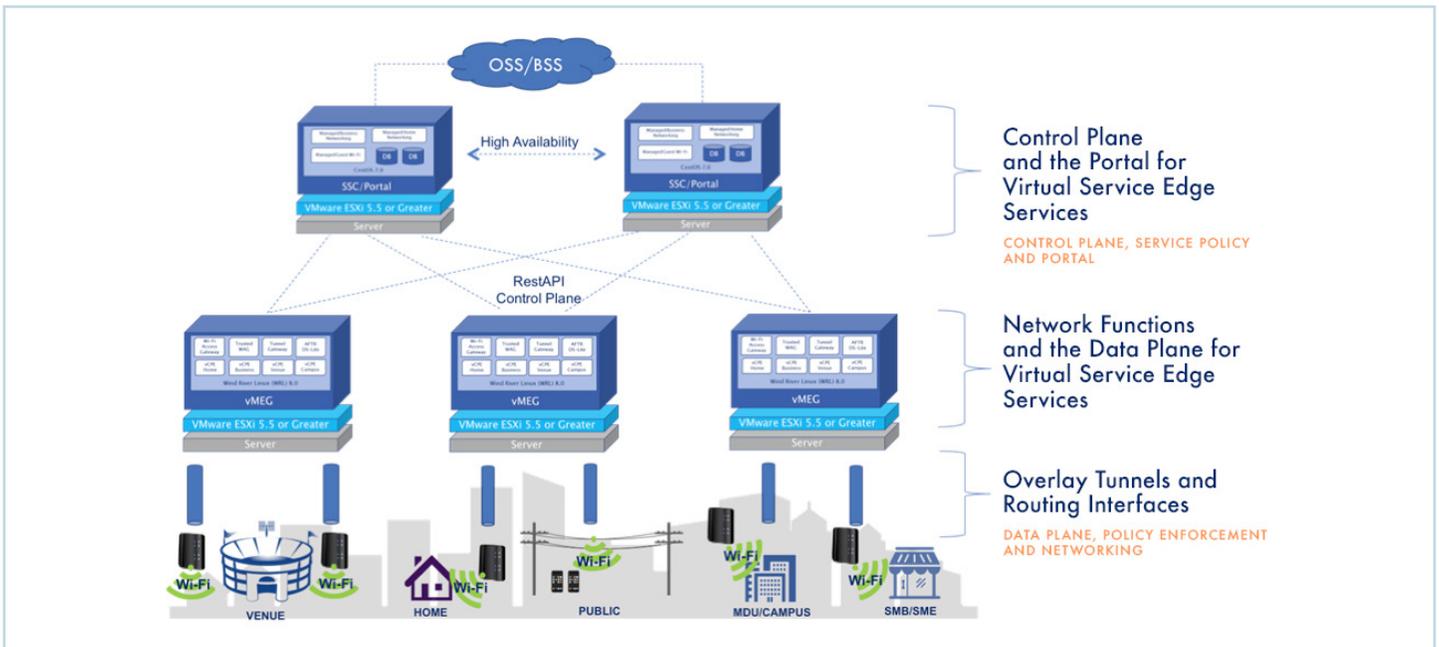
- The virtual Multiservice Edge Gateway (vMEG) is the data plane and policy enforcement component designed to scale up to millions of packets per second across tens of thousands of tunnels, and still offer a flexible platform for an operator to deploy new services. Built on a carrier-grade operating system, it has a security architecture model with strict separation of management and data-bearing interfaces.
- The Subscriber Services Controller (SSC) is the control plane and service policy control component which is deployed as a scalable cluster with both backend subscriber management, and a customizable, customer-facing GUI for a self-service configuration.

Communication between these two components is a combination of consumer and publishing messages for asynchronous event capture along with a REST API for data querying and policy control. Both components run seamlessly on top of VMware ESXi 5.5 (or later).



**VIRTUAL NETWORK FUNCTIONS ON VMware**

From an architectural standpoint, multiple vMEG instances can be deployed on VMware-based data centers. Multiple SSC instances run in high availability mode. Separation of the data plane and control plane allow operators to scale these layers independently and deploy them at the network edge.



## CERTIFICATIONS

Benu Networks' Virtual Service Edge (VSE) solution is fully certified with the following components from VMware's vCloud NFV Platform:

- VMware vSphere 6.5 U1
- VMware vSAN 6.6.1
- VMware NSX for vSphere 6.3.3
- VMware vCloud Director 8.20.0.1
- VMware Integrated OpenStack 4.0

## SUMMARY

Benu Networks' Virtual Service Edge (VSE) Platform leverages existing assets in an operator's access and core network to transform the network into a service delivery edge cloud which solves numerous challenges and permits the operator to:

- Gain visibility and service control to all devices connected to the CPE
- Improve the support and resolution of network connectivity issues
- Ensure an optimal quality of experience (QoE) to all connected devices
- Offer competitive solutions, such as service mobility and secure remote access

Benu Networks' VSE solution enables service providers to deploy a single, scalable platform on VMware infrastructure, which leverages service function chaining technologies to interface to 3rd party cloud services, to enable the delivery of numerous applications including community Wi-Fi, managed business/home networking services, managed security, and managed IoT.

## ABOUT BENU NETWORKS

Benu Networks' carrier-class Virtual Service Edge (VSE) software platform enables the rapid creation and delivery of next generation IP services over a converged infrastructure, and empowers service providers to increase revenue, expand market leadership, and meet the dynamic needs of their business, residential and mobile customers.

## ABOUT VMware

VMware, a global leader in cloud infrastructure and business mobility, helps customers accelerate their digital transformation. VMware enables enterprises to master a software-defined approach to business and IT with VMware Cross-Cloud Architecture™ and solutions for the data center, mobility, and security. With 2016 revenue of \$7.09 billion, VMware is headquartered in Palo Alto, CA and has over 500,000 customers and 75,000 partners worldwide.

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