Nokia Virtualized Service Router

Release 20

The Nokia Virtualized Service Router (VSR) is a highly flexible virtualized IP edge router. Architected and optimized for x86 server deployment in network operator and enterprise environments, the VSR is designed to:

- Enable agile delivery of new and innovative services
- Extend service reach and accelerate time-to-market
- Improve operational efficiency of next-generation IP infrastructure and services.

Based on the Nokia Service Router Operating System (SR OS), the VSR delivers a broad, rich set of virtualized network functions (VNFs) for a wide range of IP/MPLS applications.

Key features

- Wide range of supported VNFs
- High performance
- Elastic cloud scalability
- Resiliency and robustness
- Advanced VNF management capabilities

Key benefits

- Increased deployment agility and flexibility
- Rapid service introduction
- Flexible configuration and service chaining
- Lower service rollout risks
- Ease of interoperability
- Optimized use of resources and improved telecommunications and IT integration

Detailed features

Wide range of supported VNFs

The VSR applications span the full range of IP/MPLS services, encompassing:

- Enterprise services: Provider Edge (PE) for enterprise networking and interconnection of branch offices, the cloud and data centers over Ethernet and IP VPNs
- Residential services: Broadband Network Gateway (BNG), Layer 2 Tunneling Protocol (L2TP) Network Server (LNS), L2TP Access Concentrator (LAC), and Virtualized Residential Gateway (vRGW)
- Mobile services: Wireless LAN (WLAN) gateway
- IP infrastructure services: Border Gateway Protocol (BGP) Route Reflector (RR), Network Address Translation (NAT), Mapping of Addresses and Ports using Translation (MAP-T)
- Value-added services: Enabled through Application Assurance (AA)
- Security: Security Gateway (SeGW), Network Group Encryption (NGE)

High performance

To maximize its control plane and data plane performance, the VSR has been optimized for deployment in scalable, virtualized computing environments.

A high-performance control plane is required to support compute-intensive control plane tasks, and minimize routing table convergence times.

In addition, a high-performance data path is critical to ensure high-speed, low-latency packet processing and forwarding.

To deliver industry-leading capabilities for control plane and data plane functions, the VSR implements symmetric multiprocessing (SMP), a multi-threaded software approach whereby different processes are scheduled and run concurrently on different CPU cores for increased service scalability and routing performance on x86 platforms.

In addition, Nokia has optimized the interaction of the VSR with the underlying server and its input/output (I/O) ports. Technologies such as the open source DPDK-accelerated Open-vSwitch (OVS-DPDK), single root I/O virtualization (SR-IOV) and Peripheral Component Interconnect (PCI) passthrough help drive the highest possible data plane performance for the VSR in x86 environments. Also, the VSR can offload cryptographic computation to certain hardware (e.g., Intel® QuickAssist Technology - Intel® QAT), to further increase its performance – for example, its IPsec performance, when deployed as a Security Gateway (SeGW).

Elastic cloud scalability

The 64-bit software architecture of the Nokia VSR enables access to more addressable CPU memory for improved routing and service scalability.

The VSR is deployed as a single virtual machine (VM) that processes all control plane and data plane tasks. Designed as a high-performance virtual instance capable of delivering a flexible combination of specialized IP routing applications, the VSR can efficiently scale and increase its capabilities through the addition of memory and CPU processing power as required.

Resiliency and robustness

The VSR is architected and optimized for deployment on x86 server platforms to meet extreme reliability demands for the virtualized environment by leveraging the Nokia SR OS—a real-time, modular and highly available OS design.

The VSR enables creation of highly robust network architectures with advanced resiliency capabilities such as high availability, non-stop routing (NSR) and non-stop services (NSS).

Advanced management capabilities

The VSR is compliant with the ETSI Network Functions Virtualization Management and Orchestration (MANO) model.

Nokia has a comprehensive portfolio of products, fully covering the ETSI NFV architecture model and including:

- The Nokia AirFrame Data Center Solution, encompassing the necessary hardware, software and services that can adapt to any cloud-based application, including standard IT and the more demanding Telco applications
- Nokia CloudBand™, an open, modular software portfolio that makes it simple to host, orchestrate, automate and manage VNFs and services. The CloudBand portfolio includes:
  - CloudBand™ Infrastructure Software: A virtual infrastructure manager
  - CloudBand™ Application Manager: A VNF manager
  - CloudBand™ Network Director: An NFV orchestrator.

With its own complete NFV portfolio, a broad ecosystem of partners, and support of NFV standards and open frameworks, Nokia provides network operators and enterprises with a variety of choices for NFV deployment.

The VSR offers flexible management options—from open frameworks to OpenStack®-integrated VNF management and element management through the Nokia Network Services Platform (NSP).

Through the Nokia NSP, VNF management is delivered together with VSR element management and end-to-end network management. Use of the NSP, which also manages traditional Nokia 7750 Service Router (SR) applications, ensures operational consistency and service delivery assurance across both physical and virtual network environments, ensuring a streamlined operational evolution to a virtualized environment.

Centralized License Manager (CLM)

The operation of the VSR is enabled by of one or more application-specific licenses (ASL) that are related to desired functionality of the VSR. This ensures that the customers only pay for the functionality they need. All network functions supported by the VSR, as well as all network functions from other systems from the Nokia IP portfolio – delivered as physical network functions (PNFs) - come with license keys that are generated based on the ASLs. These keys are associated with a particular network function instance (physical or virtualized). In the case of the VSR, this instance is the VM.

Deployment of the VSR is facilitated by the Centralized License Manager (CLM) which governs the entitlement of VNF deployment and enables the following benefits to the service provider:

- Simplified deployment with a pool of licenses (as opposed to individual licenses);
- Improved, flexible choice of various control plane functions;
- Full control over specific individual VNFs that can be flexibly activated and deployed;
- Dynamic management of licenses in a cloud environment where VM instances may be added and removed on a regular basis.

The CLM is deployed in the customer network and manages the pool of licenses across the complete portfolio of Nokia IP routing and switching products.

Detailed benefits

The implementation of the Nokia VSR for IP routing VNFs provides many benefits:

- Increased deployment agility and flexibility: Reducing the time to deploy new networking services or optimize existing services can translate to a significant competitive advantage.
- Targeted service introduction: Enables rollout of services based on geography or specific requirements.
- Flexible configuration and service chaining: Allows innovation and creation of new services that can improve customer satisfaction and increase loyalty.
- Lower service rollout risks: Allows providers to trial and evolve services to determine what best matches new regulatory requirements or customer needs.
- Ease of interoperability: Using standardized and open interfaces allows for integration in a wide variety of deployment environments.
- Optimized use of resources and improved telecommunications and IT integration: Proven high performance with optimized use of resources on a standardized x86 compute platform for different applications, users and tenants enables rollout of profitable services based on measurable business models.

VSR architecture

Nokia has leveraged its leading expertise and innovation in service routing, and has architected and optimized the VSR for the x86-based server architecture by applying advanced design concepts, principles and approaches, including:

- Separation of control plane and data plane tasks: Allows for independent scaling of control plane and data plane within the same virtual machine (VM).
- A virtual Forwarding Path (vFP): The vFP is the x86-optimized forwarding path that supports data path functions, including access control lists (ACLs), QoS classification, policing, Forwarding Information Base (FIB) lookup, and related packet processing functions.
- Symmetric multiprocessing (SMP): Using SMP, a multi-threaded software approach whereby different processes can be scheduled and run concurrently on different CPU cores, allows for improved service scalability and routing performance on x86 platforms.
- 64-bit OS: The 64-bit software architecture enables access to an increased amount of addressable system memory for improved routing and service scalability.
- Use of acceleration techniques: Using open platforms and partnering with Intel to optimize the interaction of virtualized functions with the underlying server and its I/O, including storage. Nokia is leveraging technologies such as the OVS-DPDK, SR-IOV and PCI passthrough to consistently drive the highest possible data plane performance in x86 environments.

As a result of these advanced design concepts, principles and approaches, Nokia's flexible and robust virtualized router implementation on the VSR allows:

- Optimal utilization of hypervisor (host) resources
- High performance for both control plane (routing) and data plane (packet forwarding) functions
- Separation of control plane and data plane CPU cores
- Advanced multi-system redundancy features
- Resilient cloud scaling
- Superior life-cycle management capabilities with a unique approach to consistent operations across physical and virtualized network elements.

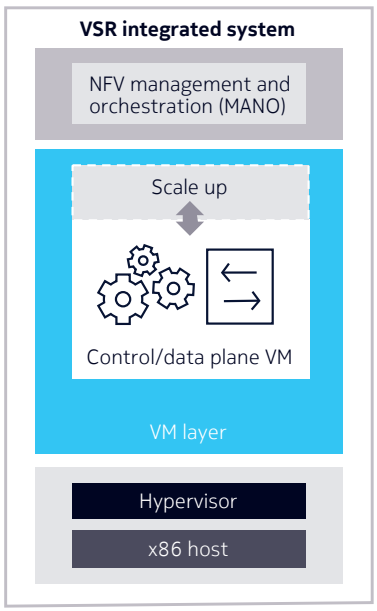
VSR deployment

The VSR is deployed in an integrated model, where the VSR control plane and data plane functionality are implemented on a single VM. In this model, the virtual CPU and memory of the VM are shared among:

- Control tasks, including:
  - Dynamic Host Configuration Protocol
  - RADIUS/Gx
  - Interior gateway routing protocols
  - Exterior gateway routing protocols
  - Routing table management
  - Policies
- Packet forwarding data plane tasks
- Optional, value-added services such as IPsec, NAT and AA
- System management tasks such as NETCONF, Simple Network Management Protocol and SSH.

The deployment model of the VSR is graphically shown in Figure 1 below.

Figure 1. VSR deployment model



Supported VNFs

The Nokia VSR supports a wide range of IP/MPLS edge services.

VSR deployments are flexible. The VSR can be deployed running a wide range of stand-alone VNFs (e.g., PE, BNG, RR, NAT, etc.) or as a single VM inplementing multiple VNFs (e.g., BNG and NAT). Customization of a VSR configuration is enabled through a modular and flexible licensing scheme.

VSR licensing allows customization and easy addition of integrated value-added services (e.g., AA, IPsec, Generic Routing Encapsulation (GRE) tunnels and NAT functions) and features such as Lawful Interception (LI).

Table 1 outlines the main VNFs supported by the VSR.

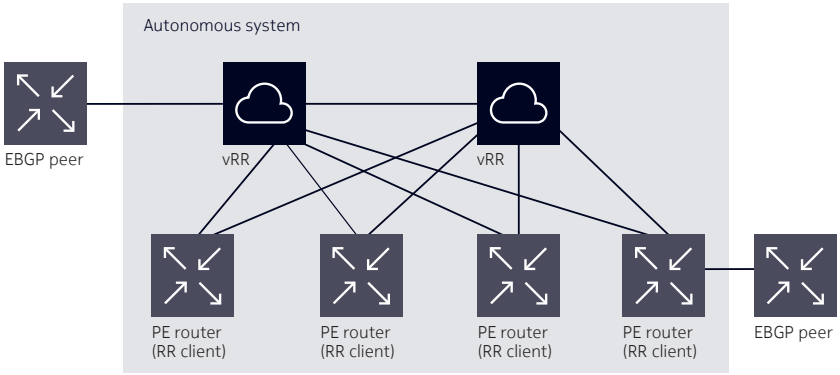
Table 1. Supported VNFs

VNF	Description
Route Reflector	• A virtualized BGP RR function that eliminates the need for a full internal BGP mesh between peers
Provider Edge	• Represents the IP/MPLS network edge for enterprise services
Application Assurance	• Enables Layer 3 to Layer 7 visibility and intelligent, policy-driven analytics and control of IP applications, with per-application, per-subscriber and per-VPN service granularity, Layer 7 stateful firewall functionality and additional features such as in-browser notifications, URL filtering, HTTP enrichment and redirect
Broadband Network Gateway	• Represents the IP/MPLS edge for residential services delivery
L2TP Network Server	• Enables connectivity to L2TP Access Concentrators (LACs) and allows the creation of a VPN over a third-party or shared infrastructure
Network Address Translation	• Enables NAT applications, allowing network operators to conserve IPv4 addresses and maintain IPv4 internet access while migrating to IPv6 (NAT44, NAT64, Dual-Stack Lite)
Mapping of Addresses and Ports using Translation (MAP-T) Border Relay	• Uses MAP-T protocol translation as a NAT technique to transport IPv4 packets over a private IPv6 network (for example, an ISP's IPv6 network) • Acts as a MAP Border Relay (BR) and implements stateless IPv4-to-IPv6 translation • Works in conjunction with stateful IPv4/port translation and stateless IPv4 to IPv6 address translation done by customer equipment (CE)
Security Gateway	• Enables comprehensive, network-integrated Layer 3 IPsec VPN connectivity for remote or network-to-network encrypted IPsec security • Delivers 3GPP Security Gateway functionality for secure mobile backhaul with additional features such as stateful Layer 7 firewall
Network Group Encryption	• Enables versatile, scalable, seamless, uniform group-based framework for encryption and authentication for any type of IP/MPLS traffic • Delivers "non-stop encryption" with flexible and easy assignment of network elements in NGE domains, and the use of Network Services Platform for robust and reliable encryption key management
Wireless LAN Gateway	• Aggregates tunneled traffic from the Wireless LAN access points
Virtualized Residential Gateway	• Enables virtualization of specific residential services functions, which have historically been implemented in the residential gateway device deployed in the home (residential CPE) • Soft-GRE tunnel access

Please contact your regional Nokia representative for additional information.

The following pages provide more information on some of the supported VNFs. For additional information about feature support and standards compliance, contact your local Nokia representative.

Virtualized Route Reflector



Overview

A Route Reflector, as specified in IETF RFC 4456, is a specific role in a Border Gateway Protocol (BGP) routing scheme where only a select number of routers—RRs—are designated as prefix distribution and policy nodes. These routers participate in volume routing topology updates and provide the best paths (according to network policy) to their clients. BGP route reflection enables highly scalable network topologies and improves overall efficiency of the network.

Route reflection is a control plane function with low impact on data plane traffic, which makes it ideal for virtualization. A virtualized RR implementation offers an alternative to dedicated routing platforms, delivering improved performance and control plane scalability.

Deployment

Virtualized Route Reflector on the Nokia VSR is operationally equivalent to the implementation of the BGP Route Reflector on the Nokia 7750 Service Router (SR) or on the Nokia 7950 Extensible Routing System (XRS) as the VSR also implements the Nokia SR OS, re-architected and optimized for the x86 server environment.

The VSR delivers RR functionality as an integrated, single-virtual machine (VM) system. The VSR also enables flexible RR deployment as: a single RR for all services, separate RRs for each service (e.g., internet, Layer 3 VPN or Layer 2 VPN) or RRs for specific groups of services (e.g., all IPv6 protocols). In addition, the VSR enables linear RR performance scaling by fine-tuning VM resources based on application needs.

As a vRR, the Nokia VSR dramatically improves overall network convergence times by performing heavy-duty BGP route processing, for which traditional network elements (designed for high-throughput applications) are not as well suited. The VSR also optimizes the use of all available CPU cores.

The Nokia VSR enables easy addition of memory and CPU resources to improve RR scalability and performance. Increased memory allows for an increased number of BGP peers and routing entries. Additional CPU resources improve performance for reflecting or advertising routes as well as improving route convergence times.

The Nokia VSR can be deployed as a vRR in all types of IP environments, facilitating internet connectivity or deployment of Layer 3 IP VPN services.

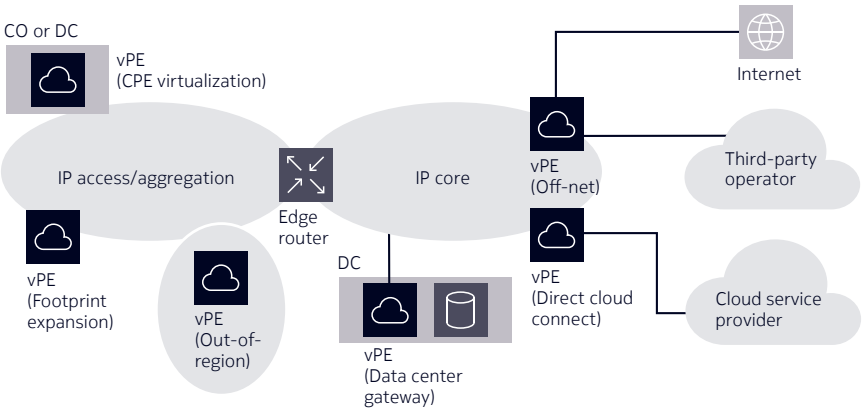
Layer 2 Ethernet VPNs (EVPNs), a next generation of Ethernet services, are also supported. EVPNs are growing in importance in the industry because they offer sophisticated access redundancy combined with Layer 3 VPN-like operations for scalability and control.

Optimal Route Reflection

The vRR implementation on the VSR comes with Nokia's innovative approach in the form of Optimal Router Reflection (ORR). ORR allows flexible placement of the VSR-based vRR functionality anywhere in the network, with the ability to define reference points independently of the physical location of the vRR. This can empower service providers' ability to create robust network architectures with optimal placement of network functions.

- Improve network performance with industry-leading virtualized Route Reflector (vRR) implementation
- Enable cloud scaling with easy addition of memory and CPU resources
- Optimize the use of available x86 hardware resources

Virtualized Provider Edge (vPE)



Overview

The virtualized Provider Edge (vPE) is an essential network function for delivering highly available Carrier Ethernet, IP VPN and internet services over IP/MPLS infrastructure. Service providers may deploy a vPE for rapid service innovation, and to extend service reach, open new markets and accelerate time-to-market. Enterprises may deploy a virtualized router as an alternative to using a physical router in their network.

Deployment

A vPE may be deployed as:

- PE router: Transition to a more elastic, on-demand deployment model and to complement chassis-based infrastructure with platform flexibility for expansion of the existing footprint or for out-of-region deployment.
- PE gateway: For off-net locations, provide internet and third-party operator connectivity from a host site with a more elastic, on-demand deployment model.
- Data center (DC) gateway: Provide an efficient way to rapidly extend connectivity between new software-defined networking (SDN)-enabled data centers and existing VPN customers in network locations where the existing PE router may not support data center gateway functions.
- Enterprise WAN router: For enterprise network locations, enable rapid value-added services with consistent operations between virtual and physical elements.

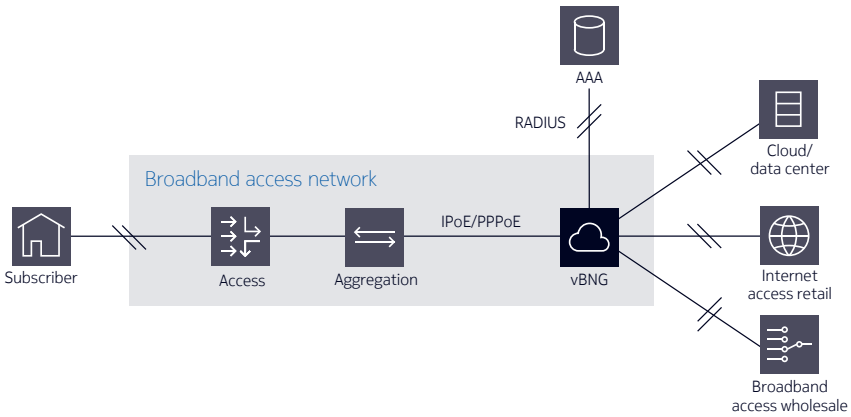
Additionally, vPE can be deployed for direct cloud connectivity – delivering guaranteed public cloud connectivity to VPN customers by directly connecting them to public cloud service providers.

The VSR-based vPE supports comprehensive IP edge routing features and can be extended with additional service options as needed:

- Application Assurance for powerful per-application QoS per-VPN analytics and policy-driven application control
- Carrier-grade Network Address Translation (CG-NAT) to manage the transition to IPv6
- Network-integrated Layer 3 IPsec VPN connectivity.

- Accelerate cloud evolution in service provider and enterprise networks
- Offer differentiated retail and wholesale enterprise services in an agile manner
- Expand enterprise services into new markets and augment service reach

Virtualized Broadband Network Gateway



- Virtualize the residential subscriber services edge to quickly address new market opportunities with a cloud-based service delivery model
- Elastically scale capacity using standard, open-source IT compute virtualization in a distributed edge or centralized data center environment
- Compatible with RADIUS authentication, authorization and accounting (AAA) to ease integration with legacy systems

Overview

The virtualized Broadband Network Gateway (vBNG) is an essential network function for network operators and internet service providers (ISPs) offering retail and wholesale services to the residential market:

- Legacy Broadband Remote Access Server (BRAS) replacement to deliver residential internet access services using a virtualized platform with elastic scaling
- Advanced subscriber management capabilities to foster a more user-centric and differentiated online experience
- To complement existing BNG network equipment addressing basic high-speed internet

(HSI) and IPTV services with a more agile service delivery architecture for the cloud era

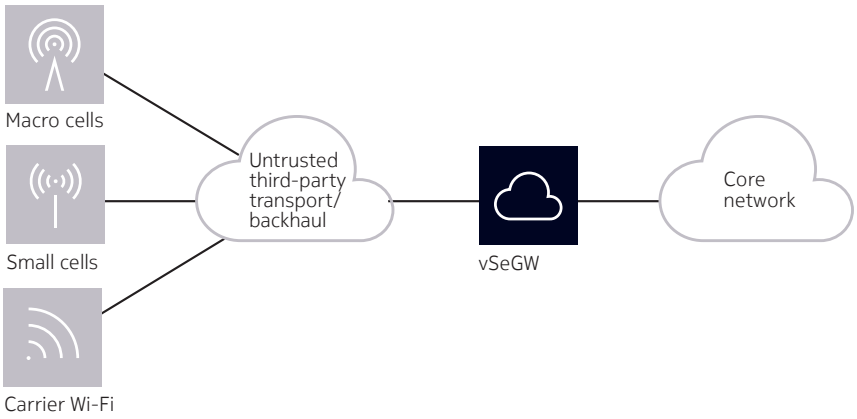
Deployment

The virtualized Broadband Network Gateway (vBNG) supports subscriber service edge virtualization for internet retail and wholesale service delivery over xDSL and FTTx access technologies, with dual-stack IPoE and PPPoE session management and RADIUS authentication. Comprehensive application QoS and security policy enforcement, and captive web subscriber portals help deliver a personalized and rich cloud experience.

The Nokia VSR as a vBNG supports enhanced subscriber management and comprehensive IP edge routing features, and can be extended with additional service options as needed:

- Carrier-grade Network Address Translation (CG-NAT) to manage the transition to IPv6
- Application Assurance, for powerful application QoS, analytics and security policy enforcement
- Advanced features such as in-browser notifications, captive portals and URL filtering

Virtualized Security Gateway



- Deploy a high-performance, resilient 3GPP security gateway (SeGW) on a carrier-grade virtualized router
- Elastically scale IPsec capacity and performance using standard, open-source IT compute virtualization
- Optimize the use of available x86 hardware resources and overall system performance, including hardware acceleration using Intel® QuickAssist Technology (QAT) for cryptographic computation

Overview

The virtualized Security Gateway (vSeGW) provides comprehensive, highly scalable and network-integrated Layer 3 IPsec-based VPN connectivity. The vSeGW functionality can be applied to any type of network traffic in fixed, wireless (cellular and Wi-Fi®) and converged environments.

The vSeGW can be used in mobile networks as a scalable and high-performance 3GPP security gateway. In addition, it can be used as a Remote Access Concentrator and a Security Gateway for site-to-site or network-to-network encrypted IP security.

IPsec services can be combined with the Nokia VSR comprehensive range of IP/MPLS services for fixed, mobile and converged network applications.

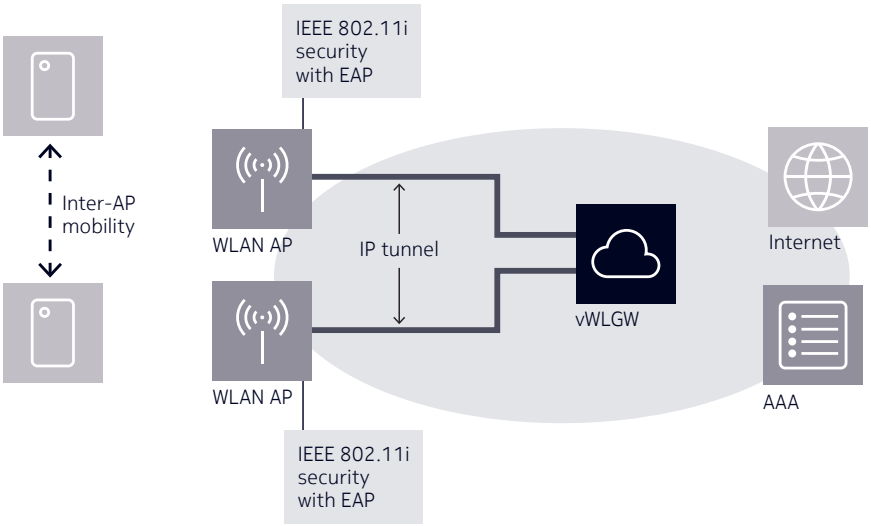
Network operators benefit from superior deployment flexibility, a rich feature set, carrier-grade performance, high availability and comprehensive support tools, enabling quick deployment and operationalization of a flexible and powerful IPsec feature set in cloud and hybrid environments.

Deployment

The Nokia Virtualized Service Router (VSR) can be deployed as a stand-alone SeGW or it can deliver SeGW functionality as an integral part of the data plane packet processing with other virtualized networking functions (e.g., Provider Edge, Broadband Network Gateway, Wireless LAN [WLAN] Gateway).

The Nokia Network Services Platform (NSP) delivers VNF and element management and allows network operators to seamlessly manage SeGW functionality from a dedicated platform (such as the Nokia 7750 Service Router or the Nokia 7450 Ethernet Service Switch) and virtualized SeGW functionality (on the Nokia VSR) using the same operations, administration and maintenance protocols and management practices.

Virtualized Wireless LAN Gateway



- Allow wireline and wireless providers to leverage Wi-Fi® access to expand service footprint
- Preserve cellular spectrum by offloading data onto unlicensed Wi-Fi
- Offer wholesale Wi-Fi access service at Layer 2 and/or Layer 3 to retail service providers

Overview

The virtualized Wireless LAN Gateway (vWLGW) supports a variety of wholesale and retail deployment scenarios, allowing both wireline and wireless network operators to leverage unlicensed Wi-Fi as an access technology. It supports a range of IP networking capabilities that enable seamless integration into existing fixed and mobile networks.

Deployment

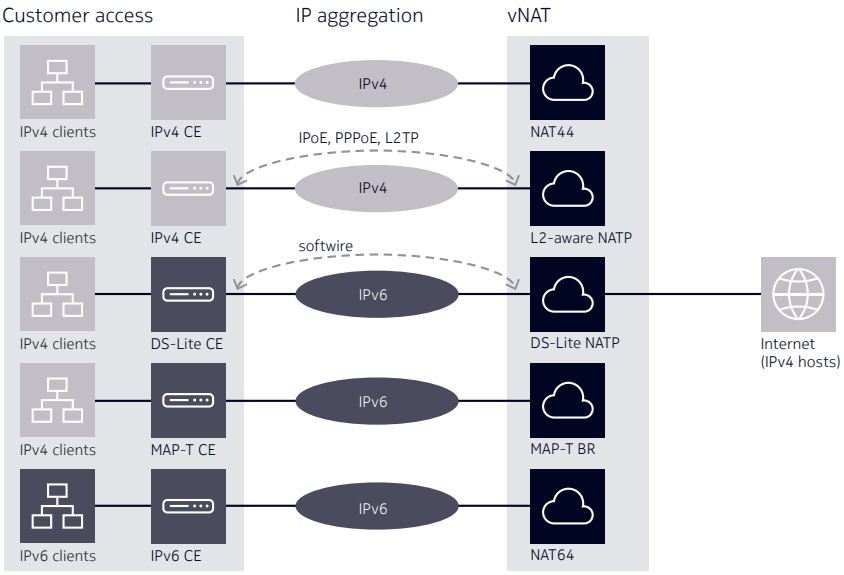
The Nokia Virtualized Service Router (VSR) can be deployed as a stand-alone WLGW or it can deliver WLGW functionality as an integral part of the data plane packet processing with other virtualized network functions (VNFs) such as a virtualized Provider Edge or a virtualized Broadband Network Gateway.

The vWLGW aggregates tunneled traffic from the WLAN access points (APs) and applies Quality of Service. The vWLGW also supports mechanisms to coordinate with the network operator's back-end subscriber, policy and billing infrastructure for authentication and parameters needed to create subscriber context.

Network operators can benefit from the high availability as well as the advanced gateway capabilities, which enable integration with Carrier-grade Network Address Translation (CG-NAT) and Application Assurance (AA) functions.

The Nokia Network Services Platform (NSP) delivers VNF and element management. The NSP allows network operators to seamlessly manage WLGW functionality from a dedicated platform (such as the Nokia 7750 Service Router) and virtualized WLGW functionality (on the Nokia VSR) using the same operations, administration and maintenance protocols and management practices.

Virtualized Network Address Translation



Overview

IPv6 is gradually gaining wide-scale deployment and acceptance in private clouds and on the internet, but IPv4 services still need to be supported for many years until the migration to IPv6 is complete. Network Address Translation (NAT) helps network operators achieve an orderly and phased transition to IPv6 and maintain IPv4 service continuity during the migration process.

- NAT44 allows many IPv4 clients to reuse the same public IPv4 address to scale IPv4 services within the confines of the available address space.
- DS-Lite (RFC 6333) allows interworking IPv4 clients with IPv4 hosts over an IPv6 access network by using tunneling techniques in combination with NAT44.
- Subscriber-aware NATP applies the soft-wire concept of DS-lite to Layer 2 subscriber sessions and is deployed as an integrated function of the Broadband Network Gateway
- MAP-T enables IPv4 interworking over IPv6 by using a stateless Border Relay at the provider edge and a stateful NAT44 function at the customer edge. This model gives better scale and performance, simplifies multi-node redundancy and reduces log data.
- NAT64 enables IPv6 clients to interwork with legacy IPv4 hosts on the internet.

Deployment

The VSR can be configured to deliver a stand-alone vNAT function (when the VSR is configured as a Provider Edge).

Alternatively, vNAT functionality can be fully integrated when the VSR is configured as a virtualized Broadband Network Gateway (vBNG) or as a virtualized Wireless LAN (WLAN) gateway. In both cases, vNAT is Layer 2-aware, and tight coupling and full synchronization of subscriber context (BNG/NAT or WLAN/NAT) is achieved.

The vNAT functionality is based on the field-proven Nokia Service Router Operating System (SR OS). The Nokia Network Services Platform (NSP) delivers VNF and element management and allows network operators to seamlessly manage integrated NAT capabilities (delivered on a service router platform) and virtualized NAT functionality using existing operations, administration and maintenance protocols and management practices.

- Versatile IPv4-to-IPv6 migration support with large-scale NAT44, Dual-Stack Lite (DS-Lite), L2-aware NATP, NAT64 and MAP-T (RFC 7599)
- Leverage standard, open-source IT compute virtualization for elastic scaling
- Deploy on general-purpose server hardware for superior investment protection

Virtualized Application Assurance

- Add high-performance and cloud-scalable stateful Layer 3 (L3) to Layer 7 (L7) packet processing to a virtualized network domain
- Quickly introduce application-based value-added services with flexible deployment policy models (network-wide, service-based or per-subscriber)
- Provide detailed analytics, reporting and control of network applications

Overview

The virtualized Application Assurance (vAA) is a virtualized implementation of deep packet inspection (DPI). The vAA functionality can be applied to any type of network traffic in residential, enterprise and wireless LAN (WLAN) environments.

The virtualized Application Assurance (vAA) enables L3–L7 visibility, analytics and intelligent, policy-based control of IP traffic flows with per-application, per-subscriber and/or per-VPN service granularity. The vAA functionality is optimized for cloud environments and allows extensive control of network applications as well as application-level reporting and traffic management capabilities.

Network operators benefit from superior deployment flexibility, a rich feature set, carrier-grade performance and comprehensive support tools, enabling quick deployment and operationalization of a flexible and powerful AA feature set in cloud and hybrid environments.

Deployment

The VSR can provide vAA functionality as a fully integrated Application Detection and Control (ADC) network function in all VSR configurations (e.g., Provider Edge, Broadband Network Gateway, Security Gateway, Residential Gateway, Wireless LAN [WLAN]), where AA tasks are performed as an integral part of the data plane packet processing. Alternatively, the VSR can be deployed as a transit AA VNF, performing as a dedicated ADC element and offering a rich set of features and options complementing IP edge and gateway systems that either cannot support an integrated ADC or that lack required features or performance.

The vAA policy models can be applied network-wide or tailored and dynamically associated with specific services types, VPNs or individual subscribers and users, using RADIUS or Diameter policy control from an authentication, authorization and accounting (AAA) server or a Policy and Charging Rules Function (PCRF).

The Nokia Network Services Platform (NSP) delivers VNF and element management and allows network operators to seamlessly manage AA functionality delivered from a physical network function such as the Nokia 7750 Service Router or the Nokia 7450 Ethernet Service Switch as well as virtualized AA functionality on the Nokia VSR using the same operations, administration and maintenance protocols and management practices.

The NSP provides comprehensive support to define and manage AA policies and policy updates, allowing operators to tailor the deployment of AA functionality to individual applications or groups of applications (e.g., multimedia, peer-to-peer, web and instant messaging).

Technical specifications

Virtualization infrastructure

CPU models

- Intel® Xeon® Processor E5-26xx v2 (Ivy Bridge)
- Intel® Xeon® Processor E5-26xx v3 (Haswell)
- Intel® Xeon® Processor E5-26xx v4 (Broadwell-EP)
- Intel Xeon 5xxx/6xxx/8xxx Gold or Platinum (Skylake-SP)

Hypervisors and Host OS

- Linux Kernel based Virtual machine (KVM) on CentOS 7.0
- Linux KVM on CentOS 7.2
- Linux KVM on CentOS 7.4
- Linux KVM on CentOS 7.5 (recommended with 16.0 SR OS)
- Linux KVM on Red Hat Enterprise Linux 7.1
- Linux KVM on Red Hat Enterprise Linux 7.2
- Linux KVM on Red Hat Enterprise Linux 7.4
- Linux KVM on Red Hat Enterprise Linux 7.5
- Linux KVM on Ubuntu 14.04 LTS
- Linux KVM on Ubuntu 16.04 LTS
- VMware ESXi 6.0 (Update 2)
- VMware ESXi 6.5 (Update 1)
- VMware ESXi 6.7 and vCenter Server 6.7

I/O virtualization

- VirtIO (with Linux KVM)
- VMXNET3 (with VMware ESXi)
- PCI passthrough
- SR-IOV

vSwitch

- Linux bridge (vhost-net)
- Open vSwitch 2.3.0 (vhost-net)
- Open vSwitch 2.4.0 with DPDK 2.1.0 (vhost-user)
- Open vSwitch 2.5.0 with DPDK 2.2.0 (vhost-user) (requires QEMU 2.5.0 or later).

DPDK

- Open vSwitch open-source DPDK (using VirtIO)

OpenStack

- RDO OpenStack Liberty
- RDO OpenStack Mitaka
- RDO OpenStack Newton
- RDO OpenStack Ocata
- RDO OpenStack Pike
- Red Hat OpenStack Platform 8 (OSP8)
- Red Hat OpenStack Platform 9 (OSP9)
- Red Hat OpenStack Platform 10 (OSP10)
- Red Hat OpenStack Platform 11 (OSP 11)
- Red Hat OpenStack Platform 11 (OSP 12)
- Mirantis OpenStack 9.0

CloudBand

- VSR lifecycle management using KVM and CBAM 18.5
- VSR Lifecycle management using CBIS 19
- VSR lifecycle management using CBAM 18.5 with VMware

VSR base system specifications

L1/L2 Networking

- Ethernet ports: Access, network, hybrid
- Link aggregation groups (LAG)
- Link Aggregation Control Protocol (LACP)
- Multi-chassis LAG (MC-LAG)
- Null, 802.1Q VLANs
- Q-in-Q encapsulation
- Configurable MACs
- Configurable MTU and jumbo frame support
- Interface statistics: Ports, service access points (SAPs), services, etc.
- Network interfaces
- Spoke Service Distribution Point (SDP) IP interfaces
- Flex PW-port: L2oGRE using IPv4 or IPv6 transport
- Flex PW-port: MPLS SDP binding
- Port cross-connect (PXC)

IPv4 and IPv6 Routing Protocols

- IPv4 and IPv6 forwarding
- Static routes
- Open Shortest Path First (OSPF) v2, v3
- Intermediate System to Intermediate System (IS-IS)
- Routing Information Protocol (RIP), Routing Information Protocol next generation (RIPng)
- Border Gateway Protocol v4 (BGP4), Multiprotocol BGP (MP-BGP)
- Address Resolution Protocol (ARP), IPv6 Neighbor Discovery (ND)

- Internet Control Message Protocol (ICMP), ICMPv6
- Equal-cost multipath (ECMP)
- Unequal-cost multipath/weighted ECMP - for BGP IP routes and Interior Gateway Protocol (IGP) shortcuts over Resource Reservation Protocol - Traffic Engineering (RSVP-TE) tunnels
- Unicast Reverse Path Forwarding (URPF)
- Virtual Router redundancy Protocol (VRRP)

IPv4 and IPv6 Multicast Protocols

- Base router and Virtual Private Routed Network (VPRN) support for the following protocols:
  - Internet Group Management Protocol (IGMP) v1/v2/v3
  - Multicast Listener Discovery (MLD) v1/v2
  - Protocol-Independent Multicast (PIM)
  - Multicast Source Discovery Protocol (MSDP

MPLS and Segment Routing

- Label Distribution Protocol (LDP) for IPv4 FECs
- Point-to-point Resource Reservation Protocol (RSVP) Label Switched Paths (LSPs)
- LDP-over-RSVP
- BGP label-unicast IPv4 (3107)
- IPv6 Provider Edge router (6PE)
- OSPFv2/IS-IS shortcuts to IPv4 prefixes (using LDP or RSVP)
- BGP shortcuts to IPv4 prefixes (using LDP, RSVP or BGP 3107)
- OSPFv2 segment routing extensions
- IS-IS segment routing extensions
- Segment Routing traffic engineering (SR-TE)
- BGP segment routing policies

Layer 2 VPNs and Datacenter Gateway (DCGW)

- E-pipe
  - Ethernet VLL signaled by T-LDP using MPLS or GRE transport
  - Ethernet VLL signaled by BGP using MPLS or provisioned GRE SDP transport
  - Ethernet VLL using L2TPv3 (static)
  - Ethernet VLL signaled by BGP-EVPN using MPLS
  - Static Ethernet VLL using Virtual Extensible LAN (VXLAN) IPv4 transport
- Virtual Private LAN Service (VPLS)
  - Ethernet VPLS signaled by T-LDP using MPLS or GRE transport
  - Ethernet VPLS signaled by BGP using MPLS or provisioned GRE SDP transport
  - Ethernet VPLS signaled by BGP-EVPN using MPLS or VXLAN transport
- Virtualized DCGW with Nuage Networks Virtualized Services Directory (VSD) integration, including support for fully dynamic XMPP Model
- Routed VPLS (R-VPLS)
- Resiliency
  - Pseudowire redundancy
  - Dual-homed VPWS/VLL
  - BGP multi-homing for VPLS
  - MC-LAG
  - STP, RSTP, MSTP

Layer 3 Services

- Internet access (IES services)
- IPv4 and IPv6 VPNs (6VPEs)
- MPLS and GRE auto-bind and spoke SDPs
- RFC 4364 IPv4 VPNs using MPLS or GRE transport
- RFC 4659 IPv6 VPNs using MPLS or GRE transport
- IP VPN inter-AS option B
- IP-in-IP and GRE IP tunneling
- GRT lookup and VPRN-to-GRT route leaking

Filtering, OpenFlow, Control Plane Protection

- Ingress IPv4 and IPv6 filters
- Egress IPv4 and IPv6 filters
- IP filter override for R-VPLS services
- All IP filter match criteria as supported by 7x50 platforms (7950 XRS, 7750 SR/SR-s, 7450 ESS)
- Standard actions: Forward, drop and HTTP redirect
- Conditional actions: Drop-extracted-traffic (for control plane protection), drop based on packet length, drop based on time-to-live (TTL)
- Ingress PBR actions: forward to next-hop, forward to router (another routing instance), redirect-policy
- NAT action
- Reassemble action
- Filter logging (ingress and egress)
- Distributed CPU protection (static policers)
- IPv4 BGP flowspec
- IPv6 BGP flowspec

- OpenFlow

OAM

- Bidirectional Forwarding detection (BFD), centralized and distributed
- Service Distribution Point (SDP) ping
- Virtual Extensible LAN (VXLAN) ping

Model-Driven Management[1]

- Configuration via model-driven (MD) interfaces (NETCONF, MD-CLI, gRPC Network Management Interface, gNMI)
- State information retrieval via model-driven (MD) interfaces interfaces (NETCONF, MD-CLI, gRPC Network Management Interface, gNMI)
- Telemetry using gNMI Subscribe RPC, supporting the following modes:
  - ONCE
  - SAMPLE
  - ON-CHANGE
  - TARGET defined

Quality of Service (QoS)

- Ingress pre-classification for class-aware early discard (optional)
- Ingress classification to forwarding-class based on 802.1p, Differentiated Services Code Point (DSCP), MPLS EXP or IPv4/IPv6 filter rules
- Egress re-classification
- Ingress and egress unicast policing and HPol
- Egress marking of 802.1p, DSCP or MPLS EXP
- Egress queue shaping based on configurable Peak Information Rate (PIR) and Maximum Burst Size (MBS)
- HQoS
  - Up to 3 tiers of egress user schedulers
  - Egress HQoS with queue parenting to port or user scheduler
  - 8 strict priority levels per egress user scheduler
  - Weighted round robin (WRR) scheduling in each scheduler level
- Aggregate SAP limit, including frame-based accounting
- Aggregate subscriber rate limit, including frame-based accounting

Service Mirroring and Lawful Intercept

- Basic LI management infrastructure
- Ether and ip-only mirror types
- Debug mirror sources: ports
- LI mirror sources: subscribers, SAPs, spoke-SDP
- Mirror destinations: SAP, spoke-SDP
- Routable LI encap (IP/UDP and IP/GRE)
- Pre-NAT (private IP) and post-NAT (public IP) subscriber mirroring/LI[2]

For additional information about standards compliance and feature support, contact your local Nokia representative.

Learn more

For more information about the Nokia VSR portfolio, please visit:
https://networks.nokia.com/products/virtualized-service-router

1 Nokia SR OS YANG model implementation on the VSR is equivalent to the implementation on the physical routers. Contact your local Nokia representative for information about the availability of specific configuration paths for model-driven management on the VSR.
2 Pre-NAT mirroring/LI is only supported with L2-aware NAT.

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Document code: SR2002041360EN (February) CID 182483