NOKIA

Virtualization realized: IP routing optimized

The telecommunications industry is in the process of a major transition in how we design, build and operate networks. Services that run on these networks must become more dynamic, more responsive, and much simpler to provision and manage. The cost and time required to deliver these services must also decrease.

A key building block in the delivery of residential, enterprise and mobile services in an all-IP environment is a part of the network commonly referred to as the services edge. Responding to industry changes, the IP/MPLS services edge will transform to become a flexible set of network functions that can be deployed either in virtualized environments or through specialized, high-performance routing hardware — or as a hybrid combination of both.

With a flexible IP/MPLS services edge, market economics and specific requirements for service reach and scalability can drive the optimal deployment architecture. Network functions virtualization (NFV) of the IP/MPLS services edge will allow service providers to innovate and bring new services to market faster while realizing the benefits of the underlying server-based infrastructure, commonly referred to as the telco cloud.

Optimizing IP routing for the cloud era

To help service providers deliver more dynamic network services flexibly and efficiently, Nokia provides the Virtualized Service Router (VSR): the industry's most advanced virtualized IP/MPLS edge router.

The VSR builds on over a decade of leading IP routing expertise gained by working with over 700 service providers worldwide.

Leveraging and optimizing the Nokia Service Router Operating System (SR OS) for the x86 server architecture, the VSR allows deployment of leading IP/MPLS edge functionality in virtualized network environments with simplified life-cycle management, operations and maintenance.

With the Nokia VSR, service providers can realize the many benefits of NFV for IP/MPLS networks. NFV enables:

- **Elastic cloud scalability:** Scaling up or down of services to address changing demands
- **Increased agility:** Reducing the time to deploy new networking services or optimize existing services
- **Flexible deployment and service chaining:** Allowing service providers to innovate and create new services
- **Targeted service introduction:** Based on geography or specific requirements
- **Lower risk:** NFV infrastructure allows providers to trial and evolve services to determine what best matches customer needs
- **Ease of interoperability:** Using standardized and open interfaces
- **Better utilization of resources and telecommunications and IT integration:** Using standardized x86 compute platform for different applications, users and tenants

Delivering IP services breadth, scalability and performance

Whether an IP or Ethernet network service is running in a virtualized environment or on specialized hardware platforms, the customer experience must be the same. Virtualized routers must deliver the same service experience and reliability that customers have come to expect.

Nokia understands these requirements and has developed the VSR software suite to offer the industry's broadest set of virtualized IP edge applications and services. The VSR delivers proven high performance in an x86 environment and is designed to support the highest levels of reliability and resiliency.

A new approach to scalability ensures fast, cost-effective and efficient scaling as required. Unified management capabilities ensure operational consistency across both the physical network functions (PNFs) and the virtualized network functions (VNFs).

Unmatched IP/MPLS services breadth

Nokia VSR applications span the full range of traditional IP/MPLS edge services, including:

- **Business services:** Provider edge (PE) for Ethernet and IP VPN services
- **Residential services:** Broadband Network Gateway (BNG) and virtualized residential gateway functionality
- **Mobile services:** Wireless LAN (WLAN) gateway and security gateway

The VSR can also be deployed to flexibly scale IP routing-infrastructure, for example when deployed as a virtualized Route Reflector (RR).

In addition, the VSR supports a number of value-added functions, including Application Assurance (AA), a feature set for traffic classification and policy enforcement based on Layer 4-Layer 7 deep packet inspection (DPI) and application classification.

New approach to scalability

As a software-based service router, the VSR brings a new approach to scalability for IP routing applications and services. The VSR can be deployed on a single virtual machine (VM) and leverage scale-up capabilities of the underlying x86 platform by adding additional CPU, memory and/or input/output (I/O) resources.

The VSR can also be deployed in a distributed model, with different applications or tasks shared across multiple VMs. As demand for the routing application increases, more VMs can be added quickly to support scale-out. This technique allows for highly efficient scaling because different functions that require additional capacity can be scaled independently as required.

High performance on x86 servers

The VSR has been architected to optimize and maximize the performance of both control plane and data plane functions. Control plane and data plane functions are fully separated and running on separate VMs, which allows flexible scaling of both.

A high-performance control plane is required to support fast routing-convergence times and to ensure advanced operations, administration and management (OAM) across many service flows. To maximize control plane performance on x86 platforms, the VSR is designed for multicore processor environments.

Nokia's implementation of symmetric multiprocessing (SMP) on the VSR enables different control plane tasks to be scheduled and run on different processor cores concurrently. The 64-bit software architecture enables more memory to be accessed more quickly. Combined, these two features enable the VSR to deliver unmatched service scalability and routing performance on x86 platforms.

Data path performance is also critical to support high-speed services, a large number of subscribers and scalability. With SMP, the VSR has the power and performance of multicore processing for data plane tasks. To improve the performance of the data path, the VSR communicates directly with the hypervisor to load specific drivers and optimize data path performance.

In addition, Nokia has partnered with Intel to optimize how the VSR interacts with the underlying server and its I/O ports. Tools such as the Intel® Data Plane Development Kit (DPDK) and Single Root I/O Virtualization (SR-IOV) are used to provide the highest possible data plane performance for the VSR operating in x86 environments.

Architected for high availability

In today's high-performance IP/MPLS networks, ensuring a high-availability networking environment is crucial. With network connections and service flows running at gigabit speeds, even a small network disruption can impact thousands of subscribers and lead to severe outages and SLA penalties.

The VSR is architected to meet the reliability demands of an always-available service environment. Based on a modular and highly fault-tolerant software architecture that is optimized for the x86 environment, the VSR has strict separation between the control plane and forwarding plane. Building on this separation, a number of carrier-grade resiliency features have been implemented to protect both the control plane and the data plane.

This approach enables the delivery of non-stop routing and non-stop services, in case of control plane or data plane failures. With in-service software upgrades (ISSUs), software updates can be performed on a live system without a service-impacting system reboot. In addition, multi-system synchronization across separate instances of the VSR allows stateful switchover from one system to another in the event of system, link or network failure, with minimal or no impact to services in progress.

Unified management and operations

The VSR is managed by the Nokia 5620 Service Aware Manager (SAM) for easy integration in end-to-end Nokia IP routing and transport networks. The Virtualized Network Function Manager in the 5620 SAM performs all VNF life-cycle management functions while the 5620 SAM delivers element management and end-to-end network management. With the 5620 SAM, operational consistency is ensured across both PNFs and VNFs.

Ensuring a high-performance, super-scalable, highly reliable virtualized environment is critical for a cost-effective telco cloud deployment.

Virtualizing network functions and services

The gradual implementation of virtualized IP/MPLS routing and edge services will be part of a network transformation journey that will introduce new network architectures and deployment models. Nokia is at the forefront of developing, testing and challenging the limits of virtualized routing functions and IP/MPLS services. Here are some of the routing applications and edge services for the VSR.

BGP route reflector

A route reflector is a key routing (control plane) network function that enables large-scale IP networks to be built more efficiently. A route reflector is a centralized network focal point with which multiple BGP routers can peer; this eliminates the need for each individual router to maintain direct visibility to every other router in the network.

The Nokia VSR Route Reflector (VSR-RR) is a software-based BGP route reflector function that eliminates the need for a full internal BGP mesh between all routing peers. BGP route reflection on the VSR-RR is functionally and operationally equivalent to a Nokia 7750 Service Router (SR) route reflector, with the added benefits of improved flexibility, scalability and performance for x86 environments.

Powered by innovations such as parallel SMP and a 64-bit OS, the VSR-RR takes full advantage of virtualization to set a new benchmark for route reflector performance and scalability.

Application Assurance

To help service providers remain competitive in the residential, enterprise and mobile services markets, Nokia offers application-based services and application-level reporting and traffic management capabilities with its VSR Application Assurance (VSR-AA). The VSR-AA leverages DPI techniques to provide Layer 4-to-Layer 7 visibility into the type of traffic being carried across the IP network. This information can then be used to provide real-time, policy-driven control of IP applications at the per-application, per-subscriber and per-VPN service levels.

The VSR-AA can also operate as a standalone application detection and control (ADC) network application to complement IP edge gateway platforms that do not support an integrated ADC function.

IP/MPLS provider edge

The provider edge (PE) in an IP/MPLS network is the interface between the enterprise access network and the IP/MPLS core. The processing and enforcement of enterprise network service policies occurs at the PE. The Nokia VSR Provider Edge (VSR-PE) provides advanced support of Carrier Ethernet (Layer 2) and IP (Layer 3) VPN services with elastic control-plane and data-plane scalability. The VSR-PE provides a new value proposition for supporting VPN needs across enterprises of all sizes.

Broadband Network Gateway

The Nokia VSR Broadband Network Gateway (VSR-BNG) is a virtualized BNG that supports the subscriber service edge for high-speed Internet residential service and access to cloud-based applications and content. With support for IP over Ethernet (IPoE) and Point-to-Point Protocol over Ethernet (PPPoE) session management, comprehensive QoS, and security and policy enforcement features, the VSR-BNG provides network operators and access service providers an easy transition to NFV while offering elastic scaling on x86 servers.

Service router simulator

For lab environments and training purposes, Nokia offers the Virtualized Service Router Simulator (VSR-SIM). The VSR-SIM provides full emulation of the 7750 SR, offering simulated configuration of its full range of IP/MPLS routing functions and services. The VSR-SIM is intended for trials, training and network simulations.

Nokia is at the forefront of developing, testing and challenging the limits of virtualized routing functions and IP/MPLS services.

Driving NFV innovation and adoption

The VSR is proof of Nokia's commitment to and belief in the value of NFV in the evolution of networking. As such, it is a part of Nokia's leading NFV portfolio, which addresses all the major elements of "the ETSI NFV framework.

Nokia recognizes that transitioning networking to the cloud goes beyond just the delivery of VNFs. With this in mind, we provide a full solution that encompasses all elements of the NFV environment.

In addition to a wide range of VNFs, our NFV portfolio includes:

- 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

The NFV portfolio is further complemented by a leading software-defined networking (SDN) portfolio of products from Nuage Networks™, a Nokia company.

Nokia also brings unique insights to the development of VNFs. As an active member of the ETSI NFV advisory board, we are fully committed to standardization, industry collaboration and working with open-source software and open frameworks. The company has strategic partnerships with industry leaders, including Intel and Red Hat, to further accelerate NFV innovation and adoption.

We provide flexible cloud solutions that give you the freedom you need for successful implementation. While we offer fully pre-integrated NFV solutions that can speed time-to-market, all our NFV elements are built to operate in an open, multivendor environment. We support secure integration of multivendor platforms and applications, taking into account your current network, appropriate virtualization technologies and your existing and potential partners.

Nokia can help you on your journey to the cloud with a full set of cloud services, from consulting, to design and build, to operations and maintenance.

Providing new application and service opportunities

With a flexible IP services edge, networking applications and services that could not previously overcome the ROI hurdle to proceed to commercialization are now possible. New ideas can be explored and new service combinations can be created. All can be easily tested in the market with lower up-front financial commitment and risk, then quickly scaled to mass deployment.

The flexibility to scale up or scale out in a virtualized environment also introduces new opportunities for offering profitable time-limited or short-term services.

A flexible IP services edge with virtualized service routing enables a range of applications and services, including:

- Distributed, virtualized routing applications, with lower throughput and scalability for capturing smaller or out-of-region locations where the cost of a traditional PE router is too high
- A virtualized route reflector as a non-disruptive way to scale the IP network
- Integration of high-capacity, secure Wi-Fi® as a trusted mode of access
- Advanced, scalable residential services with access to value-added functions such as firewall, AA, Network Address Translation (NAT), IPoE or PPPoE, and enhanced subscriber management deployed as virtualized applications in the network

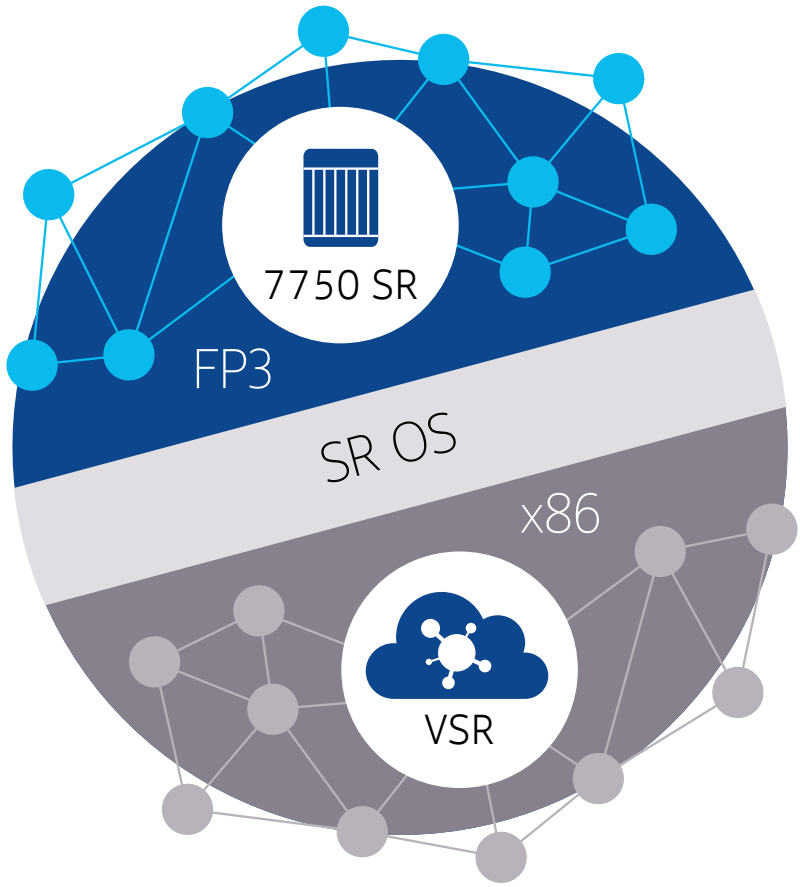
Optimized IP solutions with Nokia Service Routers

Nokia's leading portfolio of edge service products is based on Nokia's flagship IP/MPLS edge router, the 7750 SR, a product that uses a third generation of custom silicon (FP3 400 Gb/s). The Nokia VSR complements this family of products with virtualized edge routing, delivered from the VSR, which is optimized for x86 hardware.

Because the VSR and 7750 SR support the same software (SR OS) and are both managed by the same network management system (the 5620 SAM), many hybrid scenarios are possible.

With the Nokia Service Router portfolio, networks can be optimized with the most appropriate routing function delivered at the right network location — from the most appropriate platform.

With our flexible and optimized IP/MPLS portfolio, service providers can create scalable, reliable, high-performance network architectures that allow them to become more dynamic — and drive new and optimized services to market faster.



For more details on virtualized IP network functions available on the Nokia Virtualized Service Router, please visit the Nokia VSR web page.