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WHITE PAPER

Network Edge Innovation With Virtual Routing

A Heavy Reading white paper produced for Juniper Networks Inc.

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INTRODUCTION

Network operators are increasingly turning to network functions virtualization (NFV) to overcome the inflexibility and inefficiencies imposed by traditional, hardware-centric infrastructures. In fact, NFV-based solutions have been validated in production networks globally, and many communications service providers (CSPs) are using it to improve network and service agility, contain operations costs and accelerate network buildouts.

This paper explores the possibilities offered by virtual edge routing and highlights proven use cases where virtualized edge routers have helped network operators accelerate time to market and improve business opportunities and outcomes. The paper also provides general guidance regarding selection criteria for virtual edge routers.

NETWORK VIRTUALIZATION

Network Function Virtualization (NFV) Overview

Traditionally, network operators build out their edge network infrastructures with specialized elements and service-specific appliances. This approach constrains innovation, because new services require new hardware – with typically long and expensive qualification, integration and implementation cycles, and can be inefficient, especially at low scale. Furthermore, creating a broad service portfolio results in appliance proliferation, which complicates network design, management and operations, and also consumes valuable space and power.

NFV, on the other hand, decouples the network functions from the underlying hardware, and instead runs these services on commercial-off-the-shelf (COTS) x86 servers. This approach offers several major advantages; for instance, multiple virtualized network functions (VNFs) can efficiently share a single server, resources can be easily reallocated, and functions can be independently and elastically scaled, all of which reduces costs and increases network agility. NFV permits the evolution to more agile, software-centric networking.

ROUTER VIRTUALIZATION

Virtual Edge Routing Improves Network Agility & Efficient Scale-Out

While virtual routing use cases exist across network domains, their ability to easily and rapidly scale up bandwidth and services is a major advantage in the CSP edge network.

CSPs traditionally implement a combination of physical routers and appliances in their network edge. This deployment model is optimized for centralized service delivery and high traffic volumes, but it can be inefficient and expensive for low-bandwidth applications, creating an artificial barrier to entry into new markets and services.

CSPs can utilize virtual routers for distributed edge architectures, agile service introduction of lower-bandwidth applications, and to meet short-term service requirements associated with special events and low-risk expansion into new markets and geographies. CSPs can also use them as part of managed service offerings, to offload control-plane-intensive protocols from physical edge routers, and as part of a transition to NFV and software-defined networking (SDN). These use cases are explored in more detail in the following section.

VIRTUAL EDGE ROUTING USE CASES

CSPs are currently using virtual routers in a wide variety of edge use cases, including the data center, the network edge and in customer premises equipment (CPE). The migration to 5G wireless and virtualized CPE (vCPE) will accelerate vRouting adoption by CSPs.

Virtual Provider Edge

Virtual routers can be used to provide traditional provider edge services, such as IP/MPLS virtual private networks (VPN) services. When deployed as a virtual provider edge (vPE), comprehensive support for a broad range of Layer 2 and Layer 3 routing, as well as encapsulation protocols – including Source Packet Routing in Networking (SPRING)/Segment Routing (SR), Ethernet VPN, VxLAN and IPsec – is critical to allow architectural and service evolution, and to meet the widest variety of market requirements.

Virtual Broadband Services

Virtual routers can be deployed as Broadband Network Gateways (BNGs) and Layer 2 Tunneling Protocol (L2TP) network servers, in support of residential and wholesale broadband services, respectively. In this role, the virtual router must support all routing protocols as well as a host of residential-service-oriented protocols, such as Dynamic Host Configuration Protocol (DHCP), point-to point Protocol over Ethernet (PPPoE), Pseudowire Headend Termination (PWHT), and RADIUS subscriber interfaces.

Virtual Route Reflection

Route reflection is an ideal application for virtual routers, permitting cost-effective high performance and elastic scale to accommodate route increases over time. Virtual routers can offload route-reflection from physical routers, which not only avoids the risk and expense of upgrading physical routers, but also extends their useful lifecycle by freeing up precious processor cycles.

Managed Services

While technically not an edge use case, CSPs are deploying virtual routers as a key ingredient of managed service offerings, including use cases that leverage vCPE. The virtual router can be deployed as a VNF on a COTS server, together with other VNFs supporting firewall, application acceleration, IPsec, network address translation (NAT) and other virtualized functions to provide highly customized services. This approach replaces complex and expensive Layer 3 CPEs with simple, low-cost Layer 2 CPE devices and results in significantly lower capex and opex.

Virtual Cloud Gateway

Many large enterprises behave like CSPs: They maintain expansive wide-area networks (WANs) that span continents and manage complex hybrid cloud environments. Virtual routers can be used by these entities as a cloud gateway – to connect the enterprise to private and public clouds – and to extend the enterprise's private Layer 2 or Layer 3 network across the cloud by manipulating tunnel tags using Multiprotocol BGP (MBGP) or MPLS over generic routing encapsulation (GRE). This approach extends an enterprise's private network into the cloud without sacrificing security or feature consistency.

VIRTUALIZED ROUTER CONSIDERATIONS

There are several important attributes to consider when evaluating virtualized edge routers, including feature parity with physical routers – virtual routers should in no way be inferior to physical routers – as well as flexible acquisition and implementation models and support for automation, which amplifies the benefits of virtualization.

Feature Parity

Feature parity with physical routers helps to contain opex by ensuring operational consistency across both physical and virtual network environments. Even if virtual routers aren't deployed in an operational network, virtual router feature-parity enables operators to cost-effectively scale out their physical lab environment – so that they can efficiently test new features and release with greater realism – and also provide a realistic sandbox in which to educate new technicians. The bottom line: Do not sacrifice features when using a virtual router.

Flexible Acquisition & Implementation Models

To maximize investment, virtual router "packaging" needs to align with business requirements and goals. To ensure this, routing VNFs should be available in highly granular bandwidth increments, with perpetual and subscription-based licenses, and should run on COTS servers and a variety of popular hypervisors. The same VNF should also be available bundled with an appliance, for use cases and geographies where it is difficult to source technicians for integration and support. Additionally, the virtual router should be available in the public cloud, enabling simple and rapid extension of network reach while maintaining feature and operational consistency network-wide.

Integrated Automation Capabilities

Automation complements virtualization, and is necessary to help cost-effectively create and deliver highly customized services rapidly and at scale. Virtual edge routers should support the full gamut of automation capabilities, including commit and op scripts, event policies and scripts, and macros that help automate operational and configuration tasks. Additionally, virtual edge routers should be manageable by OpenConfig/YANG, and have application programming interface (API) support for all modern programming languages. Open interfaces for integration with SDN controllers, Path Computation Elements (PCEs) and management systems is also a requirement.

Advanced Protocol Support

Virtual routers offer a very simple and realistic way to evaluate innovative new protocols, services and architectures, and support for modern routing protocols, such as SPRING/SR, is especially important for virtual edge routers, because they act as the network's service creation and delivery point. Virtual edge routers let operators test-drive advanced technologies in a low-cost/no-risk environment, so they can determine if, when and how to implement them in their production network.

GETTING STARTED WITH JUNIPER

The simplest way to get started is with a free virtual routing trial that can be conveniently evaluated in a lab or in the cloud. The Juniper Networks vMX is one way to do this. The vMX is a full-featured, carrier-grade router that extends more than 20 years of Juniper routing expertise to the virtual realm.

The vMX maintains feature and operational consistency with physical MX Series 3D Universal Edge Routers, including SPRING/SR support. It has been operationally deployed by CSPs worldwide, in support of business and broadband services, route reflection, as a cloud gateway, and as a component of vCPE applications. The vMX can be deployed on preferred COTS servers or pre-bundled on an appliance, and is supported on the VMware ESXi hypervisor and Kernel-based Virtual Machine (KVM) hypervisor. It provides APIs for automation and integration with Juniper Networks Contrail Controller and Northstar Controllers.

The vMX trial software is available directly from Juniper Networks, or on Amazon AWS or Microsoft Azure.

CONCLUSION

Virtual routers are a highly effective alternative to physical routers in many edge use cases and applications, where they can help simplify the network while accelerating service introductions, improving service agility and exploiting market opportunities. By running edge routers as VNFs on commercial servers and taking advantage of automation, operators can also contain or even reduce total cost of ownership (TCO), versus comparable hardware-centric solutions.

Once virtualized, the edge routing functions can be dynamically allocated and elastically scaled, creating even greater efficiencies; there is no need to acquire, ship, rack and configure physical routers to meet forecast and unexpected demand. By exploiting the elasticity of virtual routing solutions – together with automation and SDN technology – operators can rapidly scale out services and efficiently scale up capacity, while decreasing TCO compared with physical router deployments.

Because the edge router is the service creation and delivery point in the CSP network, it is critically important that network operators only accept full-featured virtual edge routing solutions. No compromises are acceptable in this critical network domain. These solutions should be available in a wide variety of packages to optimally address the widest range of business and technical requirements for today and tomorrow.

Importantly, many virtual routing use cases are operational today in some of the world's largest networks, using generally available virtual routing solutions. This is part of a broader trend toward NFV that will only increase in the future, and operators can confidently explore, adopt and expand their use of virtual routing as their unique business goals dictate.