Virtualization to Transform Service Provider Business and Operational Economics

Enabling Agile Service Innovation

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Executive Summary

Service providers face many challenges as connectivity becomes a commodity and increasingly discriminating consumers seek increasingly customized services. Today's edge networks are hardware-centric, complex, and they inhibit service agility and velocity. Perhaps most troubling, scaling and upgrading services requires tremendous upfront capital investments that create outsized risks for service providers, all but limiting them to the most proven markets and services.

These dynamics have service providers of all types seeking evolutionary technologies to help them transform their business and operations economics, turning traditional edge infrastructures into more agile, efficient, and service-focused networks that are closely aligned with their business goals. One particularly promising technology is Network Functions Virtualization (NFV), which decouples a wide range of network functions from specialized hardware elements and enables their operation as software on commercial off-the-shelf (COTS) x86 servers. Compared to current infrastructure, NFV increases revenue and margins by reducing the time, cost, and complexity associated with service innovation.

Routers, the foundational service element in the network edge, are an ideal target for virtualization, depending on the need. This paper examines the challenges that virtualized edge routers must overcome and the benefits they can provide in several potential use cases. This document is intended for product managers seeking innovative ways to efficiently deliver edge services to business, residential, and mobile consumers.

Introduction: The Challenge at the Network Edge

Today, life moves at Internet speed. Businesses rely on instantaneous and uninterrupted communications between their employees and with their partners and customers, wherever they might be. Outside of the office, consumers spend a significant portion of their lives online staying connected—learning, keeping organized, and being entertained.

These consumers, however, have grown more sophisticated and want more than just network connectivity. Whether a business requires a mix of managed services to satisfy their unique requirements or a residential customer needs a bandwidth boost while gaming, the trend is toward customization, and it's irreversible.

Cloud computing accommodates this new reality, enabling "anywhere, anytime" access to applications, computing, storage, infrastructure, and other resources, as well as providing end users with the ability to easily modify services in near real time. The utility and value of the cloud is validated by sustained double-digit CAGR over the last 15 years.[1]

With end users primed for service customization and cloud-based resources available to provide them, the bottleneck is shifting to the service provider network—specifically, the edge network. Unlike the speed and ease with which cloud-based resources can be delivered and modified, edge networks that connect businesses and consumers to the cloud remain a static collaboration of routers, firewalls, load balancers, caches, and many other service-specific elements. These hardware-centric networks make it difficult and expensive for service providers to create and modify services in *months*, let alone in real time.

Further, due to a lack of automation, mass customization is all but impossible. Network changes are risky, and service innovation is stifled due to the costly and lengthy process of qualifying, acquiring, installing, and testing new equipment.

Given these issues, the industry has arrived at an inflection point. Customers are willing to pay for a better experience and more personalization, while edge networks are preventing service providers from monetizing this demand. Transforming the network edge into a more responsive, service-centric platform creates a tremendous competitive advantage and helps service providers become a valued partner to their customers, not to mention a preferred brand in the market.

NFV: New Network Paradigm, New Business Opportunities

Service providers benefit from edge solutions that combine the best of networking and virtualization technologies to create a highly automated, cloud-like experience for service creation and delivery. NFV[2] can help service providers achieve these goals by using virtualization technology to decouple services from the underlying physical elements and appliances that support them, so that they can be hosted on standard x86 servers. NFV offers immediate and compelling advantages, especially in the edge network, given the myriad service-specific elements implemented there.

[1] From 2001 through 2016 (forecast), Cloud Computing, Cloud Storage and SAAS had 43.2%, 36.6%, and 41.7%, respectively. Awesome Cloud; www.awesomecloud.com/wp-content/uploads/cloud_computing_growth_infographic.pdf

[2] NFV standardization is governed by the European Telecommunications Standards Institute, Industry Specification Group for Network Functions Virtualization (ETSI NFV ISG). Complementary recommendations for multivendor interoperability are being developed by the Broadband Forum.

The network edge is the IP service creation and delivery point, and it is typically composed of a wide variety of elements and appliances, making it difficult to design and expensive to implement, maintain, and scale. Using virtualized routers and appliances, service providers can eliminate multiple disparate and proprietary network elements and their associated capital and operational costs. Service introduction and modification can become as simple as a software download onto standardized hardware elements, enabling service customization and accelerating service innovation.

Virtualization can also dramatically improve the risk/reward ratio of new market entry. By reducing the large upfront capital outlays required for physical equipment, virtualization can help service providers cost-effectively enter new markets with just the amount of service capacity they need. Virtualization enables services to be easily scaled in a capitally efficient, "pay-as-you-grow" licensing model. Conversely, if services are not commercially embraced, the x86 servers can be redeployed elsewhere, avoiding stranded capital by preserving existing investments, further reducing business risk.

Physical or Virtual?

Determining whether to deploy physical routers is a business decision, not a technical one. The same proven selection criteria that service providers have long used for physical router selection apply equally to virtual router selection: Can the vendor credibly support my business? Does the feature set meet my requirements? Are performance and stability as advertised? Is it cost effective for my application?

This last consideration primarily depends on scale. While there are no concrete rules determining whether physical routers using proprietary silicon or COTS x86 servers are optimal for a given use case, several characterizations generally apply.

- Physical routers have capital and operational advantages in locations that require extremely high scale—that is, hundreds or even thousands of gigabits per second of service capacity. This is often the case in centralized environments, where traffic is backhauled for service treatment, where service providers have or plan to converge their edge and core networks, and in large markets with high penetration rates, high growth rates, or both. In these cases, service providers benefit from the scale, performance, and density made possible by vendor investment in proprietary silicon.
- Virtual routers have capital and operational advantages in locations that require 100 gigabits per second or less of service capacity. This might be the case in distributed service environments where IP services are pushed closer to the customer. In smaller markets; and in new markets where the service provider is a challenger, this is not the incumbent. Virtual routers also offer advantages in markets where growth forecasts are low or uncertain. In these cases, service providers benefit from the efficiency, simplicity, and risk mitigation offered by off-the-shelf hardware and "pay-as-you grow" license models.

This is not to suggest that service providers must make an "either/or" decision between physical and virtual routers. In fact, virtual routers are an ideal complement to physical routers in many applications—an example is when service providers want to quickly introduce a new service without having to reconfigure and destabilize their existing routers. Another example is when service providers need to extend services into locations where they don't have a presence to satisfy the needs of a large enterprise customer. There might be other cases where virtual routers can be deployed to offload control plane functions in place of adding physical routers to achieve control plane scale.

Business Drivers, Business Benefits

Assure Service Agility

Service providers can grow revenue by upselling new services to current customers and by creating services for new markets, such as SMBs.

Virtual routers can be used to introduce these new services quickly, without disrupting current services or the physical routers that support them. If service providers select a virtualized version of their physical routers, they maintain operational consistency and thus leverage their existing investments in training and management. Additional virtual services can be collocated on the same x86 server as the virtual router, reside on partner networks, or both—maximizing service agility and service differentiation. As service adoption increases, service capacity can be easily scaled via software. If the market develops sufficiently to justify physical router deployments, the x86 servers can be easily repurposed.

Build Best-in-Class Solutions

By separating network functions from the underlying hardware, service providers can avoid vendor lock-in and select the supplier and application that best addresses their business goals as well as their customers' needs. In fact, when a customer has a specific appliance preference, it can be easily added as a virtualized application to an existing x86 server without imposing new hardware qualifications or impacting rack space and power resources. Service providers can create a partner ecosystem to provide highly customized and personalized services quickly, without network disruption.

Design for Cost-Effective Redundancy

Due to the diversity and sheer number of element types in the network edge—such as routers, firewalls, load balancers, and caches—redundancy can be very expensive to achieve. By virtualizing these elements, it is possible to efficiently allocate capacity on x86 servers to provide a shared pool for all applications, instead of the 1:1 redundancy normally used. Redundant capacity could even be allocated based on policy so that, if multiple failures occur, high-priority applications would be preserved or all services could be restored but at diminished capacity and performance.

Capture More Sales and Market Opportunities

Service providers might need to provide services beyond their current network footprint in order to address the needs of enterprise customers. Additionally, unanticipated market opportunities that represent a lucrative sales prospect might emerge.

Using virtual routers, service providers can quickly and efficiently capture these revenue opportunities by leasing rack space or network capacity in facilities situated near the customer or market. This avoids prolonged equipment and facility qualifications, build-to-order delays, and shipping issues, including the potential for equipment damage. By using a virtualized version of their current physical routers, service providers can maintain feature consistency across the customer's facilities and operational consistency within their own network, including remote management of services sited in distant or isolated locations.

Consolidate Services for Efficiency

Instead of implementing multiple individual elements to physically isolate different customers, which adds cost and complexity, service providers can segment a single x86 server into multiple virtual "elements."

One operationally proven example of virtualized multitenancy currently in use by service providers is virtualized customer premises equipment (vCPE). With vCPE, premise-located routers and other appliances are virtualized and moved into the cloud while a simpler network interface device (NID) is installed on the premises. This shifts complexity off the customer site and eliminates expensive truck rolls for service deployment and modification.

Upgrade Capacity Without Disruption

Vendors are always building larger elements to address traffic growth in service provider networks. In many cases, this requires an expensive "rip-and-replace" upgrade. By virtualizing routers and other appliances, service providers can leave their current physical elements in place and add scale to their networks using licenses and commodity x86 servers. This approach avoids hardware obsolescence, reduces the risk of service disruption, and saves money.

Independently Scale Functions

Routers and appliances are hardware bound—that is, the control, forwarding, and service planes ship with a fixed amount of resources. While vendors can offer upgrades to increase these resources, virtualization avoids them entirely by enabling control, forwarding, and services planes to scale independently of one another, based on actual demand.

One example is route reflector server functions. On physical routers, this function is typically hosted on a card that supports control plane functions. As the number of route reflector clients increases, performance diminishes until more cards are needed. Instead of purchasing additional routers for the route reflector server function, the service provider can easily add virtual routing resources. This not only provides cost-effective route reflector server scale, it also frees processor cycles on the physical router cards, which improves overall control plane scale and performance.

Expand While Containing Risk

Successful service providers eventually face issues with market saturation and need to expand into new geographies in order to add customers and grow revenues. Such expansion has risks, as providers face incumbents and need strong service differentiation to avoid competing on price.

Using virtual routers enables cost-effective "pay-as-you-grow" licensing and avoids the need for large upfront capital investments that negatively impact margins and delay ROI. By selecting a virtualized version of their physical routers, service providers can also maintain operational consistency and leverage existing investments in training and management. Additional virtual services can be collocated on the same x86 server as the virtual router, reside on partner networks, or both—maximizing service agility and differentiation opportunities. As service adoption increases, service capacity can be easily scaled via software. If the market develops sufficiently to justify physical router deployments, the x86 servers can be easily repurposed.

Putting It All Together

NFV and virtualized edge routing are technologies that help service providers transform their business and operations, making them more like the cloud and "over-the-top" providers. Virtual routers help service providers scale services elastically by modifying virtual capacity as needed for maximum agility and efficiency. Using x86 servers to host virtual network functions (VNFs) reduces the capital and operational costs associated with physical network elements and reduces or removes barriers to increased revenue and margins. More importantly, these NFV capabilities are complementary to physical network environments, enabling networks to evolve based on pragmatic, business-driven decisions.

Service providers can amplify the value of their NFV efforts by using automation and orchestration tools to dynamically create service chains. With automation eliminating manual intervention, virtualized services can be created, customized, and delivered in minutes rather than months, and service provisioning can be extended directly to the customer. This unprecedented level of visibility and control lets end users create their own personalized services, on demand, without compromising network scale, performance, or reliability.

Finally, service providers can implement SDN to mask the complexity of end-to-end provisioning from the customer, through the network, into the cloud, and to the applications. SDN enables automated, policy-based provisioning that considers customer privileges and requests, network conditions, and resource availability in real time in order to ensure high-quality service delivery in all network conditions.

Conclusion

Juniper Networks is in the business of network innovation that matters. Our mission is to connect everything and empower everyone. Every day, we partner with our customers to build the best networks on the planet. Whether you are seeking physical or virtual solutions, or anything in between, we are committed to your success.

You can learn more about Juniper Networks High-IQ Networks for Cloud Builders, which includes:

- Juniper Networks® vMX 3D Universal Edge Router—This virtualized Juniper Networks MX Series 3D Universal Edge Router platform allows service providers to virtualize with confidence. The vMX runs the same Juniper Networks Junos® operating system and supports the same Junos Trio chipset features as the physical MX Series, delivering virtual or physical solutions without compromise.
- Juniper Networks Contrail Cloud Solution for NFV—This is a complete, turnkey NFV solution for intelligent, automated service chaining of VNFs to create services without limits or lock-in.

These products help you rapidly and efficiently create and manage a comprehensive, hybrid virtual/physical network environment—delighting customers while profitably growing the business

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net.

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