

VYATTA, INC.

| **White Paper**

# Virtualizing Service Provider Networks:

Leveraging Vyatta Open Routing and Security Software  
to Lower Costs and Combat Sprawl

## Executive Summary

To stay profitable, service provider networks struggle constantly to achieve the right blend of:

- Decreased CAPEX
- Decreased OPEX
- Decreased power consumption
- Decreased space footprint
- Increased profitability

Virtualization has emerged as a way to balance these needs in network service provider and hosting service provider environments. Traditionally a server technology, virtualization allows multiple distinct operating systems and their applications to run in virtual machines, sharing the same server hardware. Virtualization can also be applied to networking using Vyatta's advanced routing and security software, which runs with standard virtualization systems such as VMware and Xen.

Virtualization allows you to share capital equipment costs between multiple customers or applications. Virtual machines can be provisioned electronically, on the fly, decreasing operational expenses as new customers come online and decreasing the time to first revenue for a service offering. By sharing hardware, you'll decrease overall power consumption and space footprint required per customer. All these benefits combine to increase the profitability of each end-customer you service.

With Vyatta, service providers can create virtual machines to perform networking functions on the fly, allowing new customers to be brought online without adding new hardware and while keeping operational expenses low. Moreover, because Vyatta runs on standard x86 hardware, Vyatta virtual machines can even share hardware with virtual machines running traditional applications such as file sharing or mail servers, in Linux or Windows. Vyatta is the only commercial networking solution that can be deployed in this way.

The combination of Vyatta's routing and security functionality, standard hardware, and off-the-shelf virtualization software gives service providers an unprecedented variety of deployment options—by using Vyatta as the common network platform for a range of internal and customer scenarios.

## Understanding Virtualization

To best understand virtualization, it's important to ground ourselves with a basic description of how standard operating systems work. Figure 1 shows a conventional, non-virtualized operating system sitting on top of the hardware. The operating system mediates access to system resources on behalf of each application process. When more than one application is running, the operating system gives each access to the appropriate system resources (processor, memory, disk, etc.).

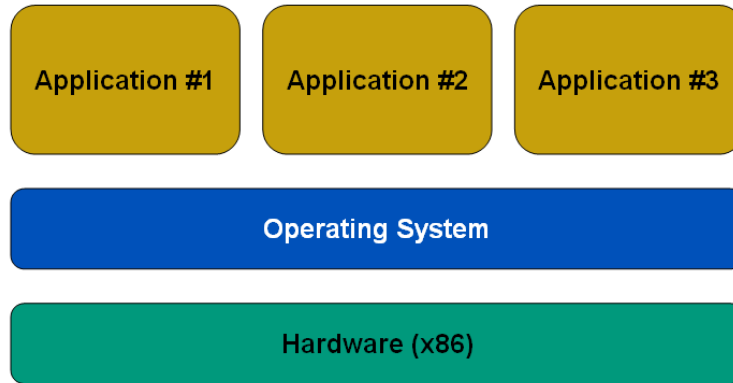


Figure 1: Standard system layering

A virtualized system, shown in Figure 2, uses a new component called a hypervisor to mediate access to the hardware. The hypervisor is a thin piece of software that creates a virtual machine (VM) abstraction. Each VM appears to be physical hardware to the operating system instance running within it. In this way, a single hardware system can support multiple VMs, each running its own operating system. Some virtualization schemes require all the VMs to run the same type OS (for example, all Linux or all Windows). More advanced virtualization systems support mixed operating systems, allowing both Linux and Windows to run on the same physical hardware at the same time.

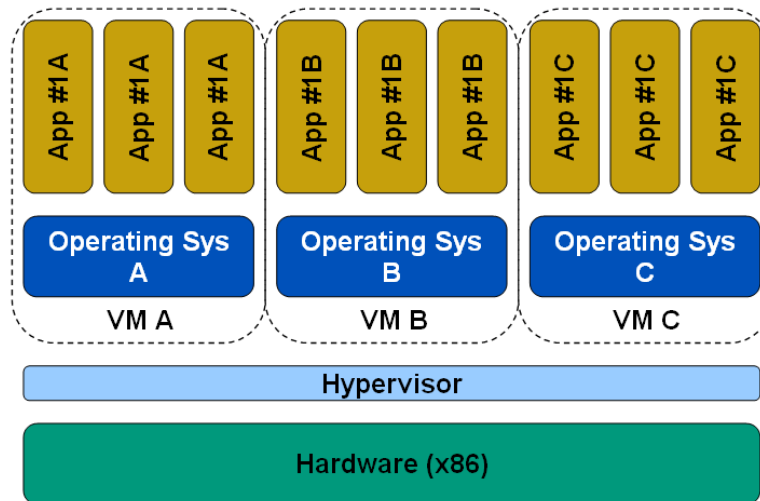


Figure 2: Virtualized system layering

Virtualization provides a number of benefits:

- **Higher system utilization**—Rather than having multiple physical systems all running at X% utilization, a single physical system will operate at approximately N\*X% utilization, where N is the number of virtual machines configured (limited to 100%, maximum).
- **Lower equipment costs (CAPEX)**—By consolidating the functions of multiple systems onto fewer physical systems using virtualization,

you get a direct reduction in CAPEX. You also save on other capital costs such as the number of spares needed.

- **Lower operational costs (OPEX)**—When operating systems run in virtual machines, network managers no longer need to deploy physical hardware for each new customer. Instead they provision new virtual machines electronically, saving physical labor and decreasing the time to first revenue. When customers leave providers—as a part of normal customer churn—the provider can quickly re-provision the associated resources for new customers, without manual labor.
- **Reduced power requirements**—By reducing the number of physical systems, we greatly reduce the power required to support a given customer base. In addition to direct OPEX reductions from buying less power, providers also save by reducing cooling and back-up power generation requirements.
- **Reduced physical footprint**—By reducing the number of physical systems in use, virtualization also reduces the sheer physical footprint required to support a given number of customers. If your data center is already deployed, this means you'll be able to support more customers, increasing the revenue per square foot. If you're looking to expand into a new location, you can plan for a smaller physical presence, decreasing lease costs and delivering a better break-even financial model.

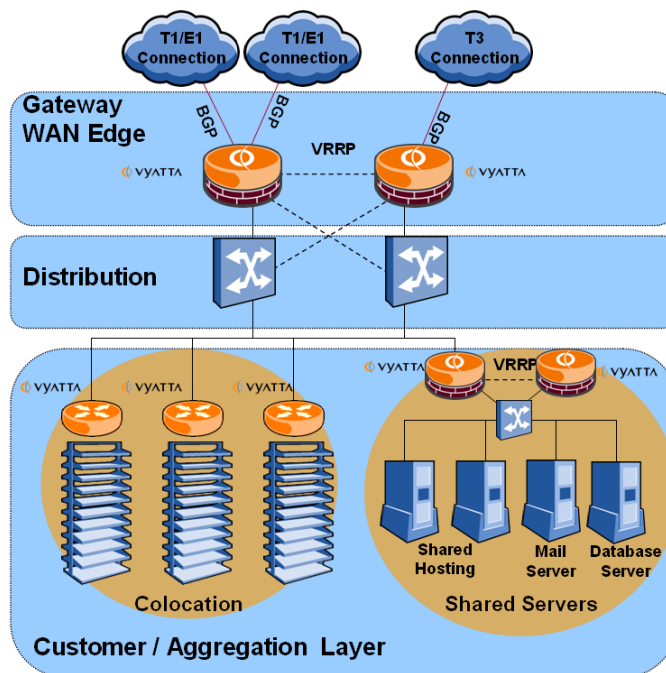
Despite the numerous benefits of virtualization, there are some additional considerations:

- **The resource equation is still a zero-sum game**—While we can drive up utilization rates on single pieces of hardware, there's no getting past 100% utilization (and we should probably provision systems for no more than 80% utilization, to provide some surge capacity). If your systems are all operating at high utilization already, virtualization won't help.
- **Some resources can't be virtualized**—While virtualization does a great job at sharing CPU resources, some resources such as RAM cannot be shared between virtual machines. For instance, if you have two physical systems using 1 GB of RAM each, you'll need approximately 2 GB of memory when you run both virtual machines on a single physical system. Typical 32-bit environments support up to only 4 GB of RAM and may, therefore, place practical limitations on the number of virtual machines that can be created. Note that over time, the switch to newer, 64-bit processors will mitigate this problem.

## Service Provider Deployments

Vyatta makes an ideal solution for service provider networks and can be deployed at many points in the topology. Depending on the scale and performance of the network, Vyatta can fit anywhere from the WAN edge to individual colocation and customer deployments. Vyatta also works well in front of shared service infrastructure. Figure 3 shows an example

colocation and hosting provider network with possible Vyatta deployment locations.



**Figure 3: Standard Vyatta deployment in a colocation and hosting service provider network**

Generally, the “Gateway and WAN Edge” portion of the network is the most performance sensitive and therefore the least suitable location to be virtualized. Because all customers share this same infrastructure, there’s little benefit to virtualizing it.

In the “Shared Servers” portion of the network, all the servers and network infrastructure are already shared by multiple customers. Here again, there is no customer-specific configuration required and little benefit to further virtualization.

## Virtualized Networking

Virtualization delivers the biggest benefits where individual customers require dedicated services and configurations but are not so performance sensitive that sharing hardware is out of the question. Mid-range colocation or WAN POPs present ideal virtualization opportunities. These environments often use multiple identical boxes, each dedicated to a single customer.

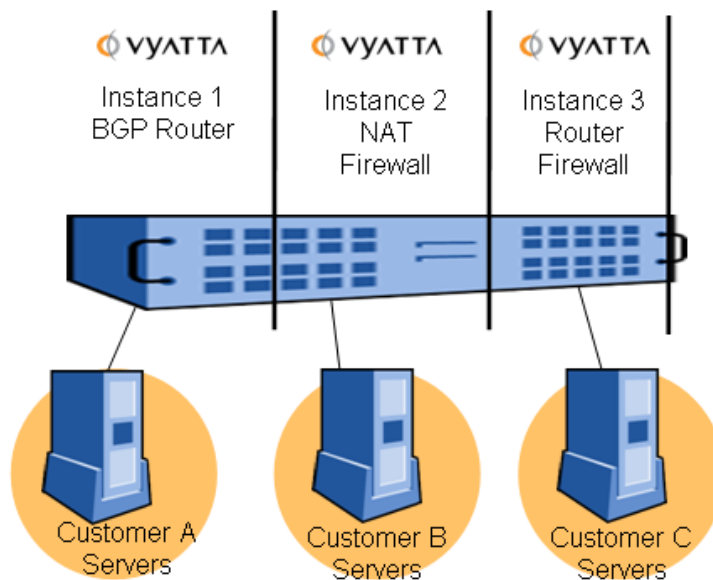
Vyatta is particularly suited for virtualized deployments and provides a number of features that proprietary networking systems cannot duplicate:

- **Vyatta uses standard x86 hardware**—Vyatta does not require proprietary network hardware. This allows it to make use of standard virtualization systems and share physical hardware with other operating systems supporting x86 hardware (e.g. Linux or Windows).

- **Vyatta supports standard hypervisors**—Whether your preferred virtualization system is VMware, Xen, or something else, Vyatta works with it.

Figure 4 shows how the colocation portion of Figure 3 looks with a virtualized infrastructure. Each of the customers (A, B, and C) requires different network services (router, NAT, firewall, etc.) and has custom configurations.

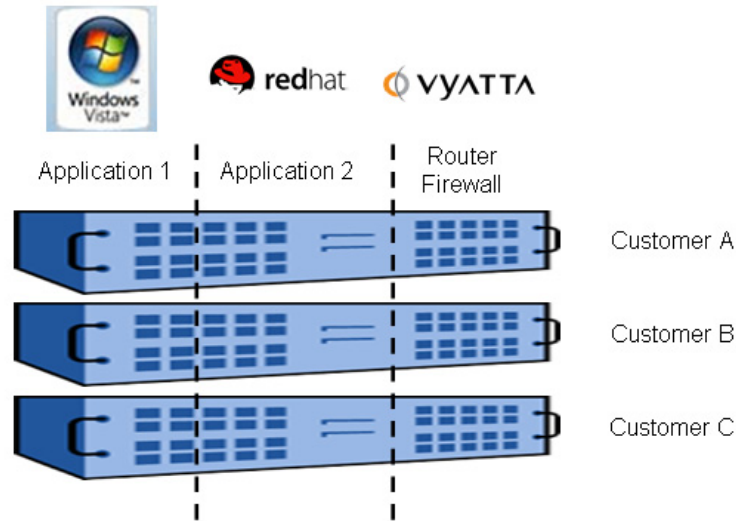
Rather than dedicate a separate hardware system to each, you can use a single hardware system with three VMs, each VM running a separate Vyatta instance. Because each VM emulates a full hardware system, each Vyatta instance is distinct and can be configured separately—and differently—from others sharing the same hardware. Customers can even have command-line or GUI management access to the Vyatta virtual machines, just as if they were physical systems.



**Figure 4: Virtualizing networking functions for multiple customers**

The technique shown in Figure 4 works well if the server infrastructure connected to the network is either owned by individual customers or is so high performance that it requires dedicated physical systems.

In cases where the service provider owns the server infrastructure (dedicated hosting providers, for instance), it often makes more sense to virtualize along a different dimension (“vertically” as opposed to “horizontally”). Figure 5 shows this technique.



**Figure 5: Virtualizing multiple applications and networking for each customer**

In the vertical design, each customer is allocated a single physical system, but the system is virtualized to support both the Vyatta instance providing network functions and one or more server operating systems providing the actual application logic. This technique allows you to group all the services (network or server) for a specific customer on one or more physical systems while still employing virtualization to reduce costs, space, and power. Further, this may allow a provider to market the virtualized infrastructure as “dedicated” since each physical system serves a single customer.

## Conclusion

Virtualization represents a profound change in the economics of service provider networks. By running multiple operating system instances in multiple virtual machines on a single hardware system, service providers can decrease CAPEX and OPEX and reduce power consumption and physical footprint. Multiple secondary benefits include decreased provisioning time (decreased time to revenue), reduced sparing costs, reduced cooling and backup power requirements, and higher revenue per square foot of space.

Vyatta makes an ideal network solution in a virtualized environment. Vyatta runs on standard x86 hardware and can be virtualized with standard hypervisors including VMware and Xen. Vyatta can be virtualized “horizontally,” with multiple Vyatta instances sharing the same hardware system, or “vertically,” with Vyatta sharing the system with Linux or Windows applications.

These features make Vyatta the most flexible networking solution available. Where required, it can be deployed on separate physical systems for maximum performance or it can be deployed virtually for maximum economic efficiency.

### FEEDBACK

Have comments on this paper? Send them to [feedback@vyatta.com](mailto:feedback@vyatta.com)