WHITE PAPER

Edge Virtualization and the MicroCloud

Benefits and Differences between Private and Public Clouds

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The benefits of public and private clouds based on virtualization are varied and well known.

In 2015, more than 50 percent of enterprises have or are adopting virtualized private clouds in the data center, and another 40 percent are evaluating virtualization solutions. Nevertheless, less than 10 years ago, the number of enterprises doing any kind of private cloud virtualization was almost nonexistent.

Some of the benefits driving this rapid adoption in the enterprise, apply equally well for small-to-medium businesses (SMBs) and the edge. These benefits include:

- Application compartmentalization — containment within the application's own O/S processor and I/O space (prevents single applications from consuming a platform's resources or affecting other applications due to problems)
- Simplified security and quality of service (QoS) policies — administration across sites, applications, and networks
- Automated application integration and orchestration — simplification of installation, upgrades, and migrations without platform reboots or network downtime
- Better scaling and platform optimization — scale is simple addition
- Improved survivability and performance — treat multiple platforms as one system

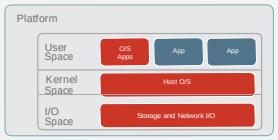
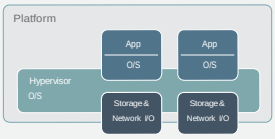
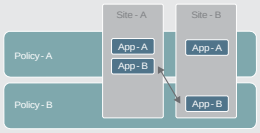
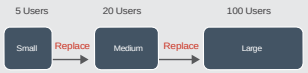
For the purposes of this paper, "edge virtualization" is described as the MicroCloud — to distinguish it from "public" and "private" clouds typically associated with the data center. The following are distinctive attributes of the edge MicroCloud (versus private and public clouds).

- It is located at the WAN interface of an SMB (typically the Internet) or a remote site in a larger enterprise (typically MPLS)
- Network bandwidth is typically constrained
- The south side of the edge (facing the LAN) is typically less than 200 devices/users
- Policy (security, QoS, NAC/Network Access Control) is typically required
- Firewall, NAT and subnet functionality are required
- The "edge" is typically price and operationally constrained
- The edge typically applies not only to network functionality but to edge applications as well (e.g., session border control, Wi-Fi controller management, etc.)

It is expected that edge virtualization and software defined networks (SDNs) will completely replace purpose-built appliances and integrated applications at the edge. These are all compelling reasons behind the move to virtualization in the data center, and these same attributes apply equally to the SMB and enterprise edge and eventually to residential applications. When considering a transition to edge virtualization and SDN, you need to look for a solution that provides both powerful networking and orchestration capabilities.

The table below illustrates some of the benefits of virtualization at the edge and is followed by a brief description of each.

Virtualization Benefits

Traditional Method	Virtualization Method	Virtualization Benefit
		**Application Compartmentalization** • Apps have own O/S and I/O • Smaller O/S footprint: increased efficiency, smaller attack surface • Better manageability of resources: critical apps get dedicated resources
		**Simplified Policy Management** • Policy administration across multiple sites • Policy administration across multiple apps • A simplification of the most complex part of application management — security and QoS policy management
		**Automatic App Integration & Orchestration** • Apps are automatically integrated with the platform and network (automatic wiring) • No long reboots of platform required in upgrades (sub-second versus minutes)
		**Scalability & Platform Optimization** • Scale is simple addition • Virtualization optimizes platform resources
		**Improved Survivability & Performance** • Virtualization allows app redundancy across platforms and even sites • Application distribution across multiple platforms

Edge Virtualization Feature Example: “Application Compartmentalization”

VIRTUALIZATION FEATURE OVERVIEW:

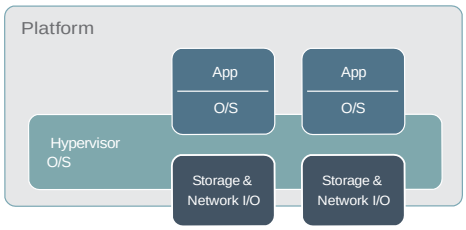


Figure 1 – Self-contained, Full-breadth Apps

One of the advantages of running on a virtual platform, versus adding an application on top of an existing O/S, is the fact that the application can run on the O/S it is optimized for, with resources dedicated for its use. This becomes especially important when the applications are deep and complete, such as with a session border controller or a voice IP key system,

particularly when these might need to run on the same platform together or with another complex-type network application.

EXAMPLE DESCRIPTION:

The following diagram illustrates one of the primary benefits of virtualization: the ability to allow an application to run in its own optimized O/S space with efficiently apportioned resources.

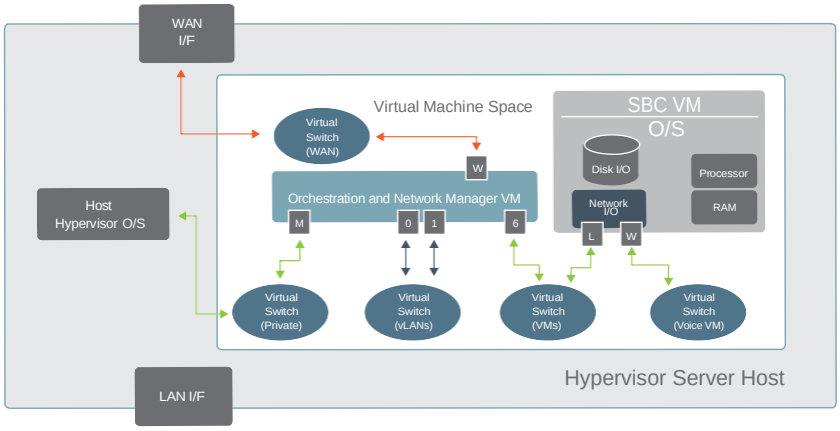


Figure 2 – Compartmentalizing an Application

In this diagram, the “Orchestration and Network Manager VM” manages the configuration of the SBC VM as it relates to the disk, network, processor, and RAM. Any additional applications are then appropriately plumbed with proper resource management. This resource allocation is very difficult to do in the absence of virtualization, inasmuch as applications tend to compete with one another in the “user space” of the O/S.

BENEFITS:

Virtualization allows for quick integration of applications within the same platform. With proper orchestration it is possible to balance application resource needs with platform capabilities. It is not necessary to fine-tune applications to a host O/S, as is done with traditional edge devices.

Edge Virtualization Feature Example: "Simplified Policy Management"

VIRTUALIZATION FEATURE OVERVIEW:

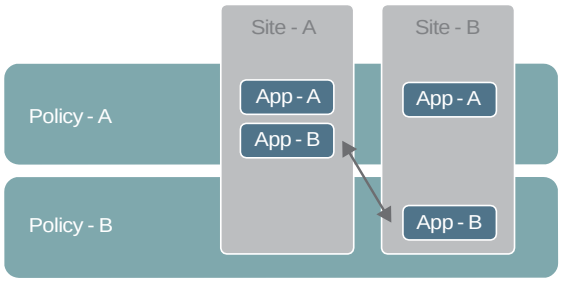


Figure 3 – Simplified Policy Management

Policy management is one of the most complex components of any networking application. It becomes particularly complex at the edge when policy needs to be applied across platforms and geographies. Examples include "guest" and "corporate" policies—particularly for wireless access. Policy is typically used to define/limit/grant access to particular resources, such as bandwidth or data for users or devices. The complexity of policy is usually prohibitive in terms of use. Virtualization with proper orchestration greatly simplifies this required but very complex component.

EXAMPLE DESCRIPTION:

The following diagram illustrates the simplification of policy management across sites. Superimposed upon a real site/policy map are guide blocks that emphasize sites (in columns) and policy (rows). The blue guide block emphasizes where policy (and routing) is set.

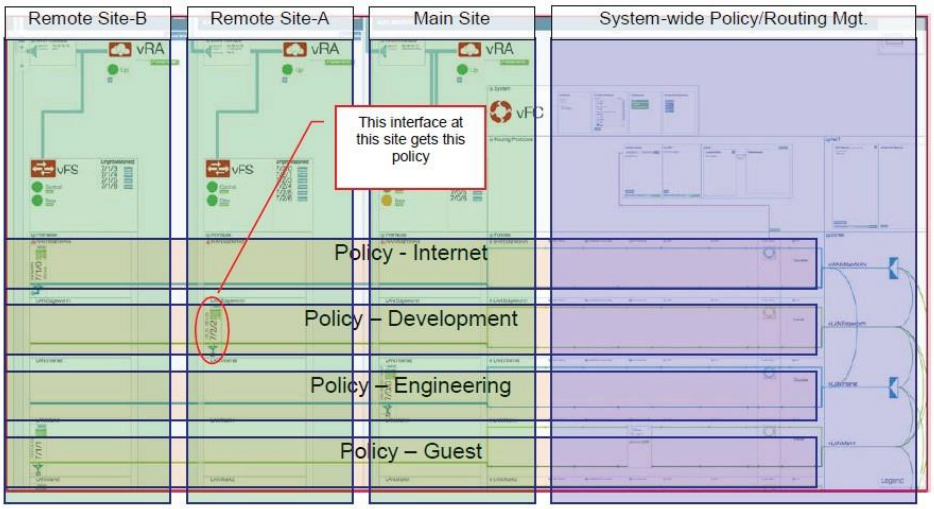


Figure 4 – Policy Management Across Sites

BENEFITS:

Policy management for security and QoS is typically complex and prone to error. Virtualization with proper orchestration greatly simplifies this critical component while improving upon the specific attributes of security and QoS.

Edge Virtualization Feature Example: "Automatic App Integration & Orchestration"

VIRTUALIZATION FEATURE OVERVIEW:

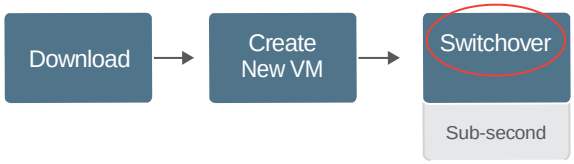


Figure 5 – Orchestration of Wiring & Upgrades

Virtualization orchestration creates several important benefits. One of the most important of these is the ability to perform automatic integration of applications with respect to the network (automatic wiring) and its associated QoS and security policies. In a traditional implementation, without the benefit of virtualization orchestration, integration tends to be fraught with errors, particularly when applied across geographies and between applications. Additionally, updates

and changes in a virtual environment can usually be orchestrated as a simple switch from a running VM to the upgraded VM, whereas a traditional environment will typically require a platform reboot—thus causing all applications to lose connectivity for a period of time.

EXAMPLE DESCRIPTION:

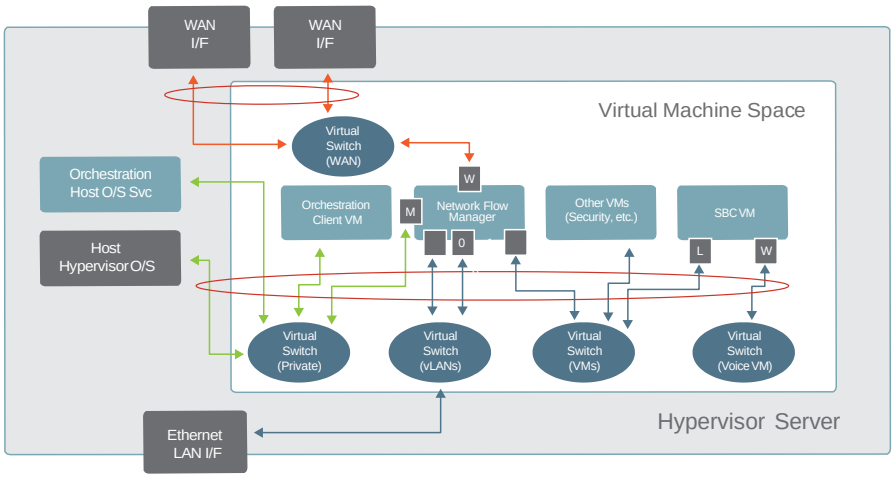


Figure 6 – Automatic Wiring Example

The following diagram illustrates the edge architecture that yields automatic app integration with virtual wiring.

Each of the colored lines represents a virtual wire (circled in red). Orchestration automatically connects these lines to the appropriate virtual switch, interface, or application.

Applications are, in turn, instantiated, configured, and plumbed by the same orchestration software. Each VM will run in its own operating system and be allocated appropriate resources. Additionally, the host hypervisor O/S and each of the VMs are isolated from each other and the WAN and LAN networks by the “network flow manager.” This isolation provides both a level of security and an improvement of application upgrades/ configurations.

BENEFITS:

Virtualization and orchestration eliminate many of the problems associated with traditional all-in-one appliances that attempt to run applications that must interact with each other and the network. Configuration mistakes are avoided, and upgrades happen with no downtime.

Edge Virtualization Feature Example: “Scalability and Optimization”

VIRTUALIZATION FEATURE OVERVIEW:

Figure 7 – Virtualization Scalability

Traditional methods of application integration usually require platform replacements in order to increase in scale. Additionally, platform optimization tends to be dependent upon the most computing-intensive application, making it difficult to balance between size and number of applications. On the other hand, virtualization has demonstrated excellent scalability and optimization value through simple addition. In fact, the trend is to reduce the size and cost of the platform, allowing more linear growth and optimization.

EXAMPLE DESCRIPTION:

The following diagram illustrates the evolution of a typical edge configuration towards smaller and less costly virtual platforms that can provide scalable and optimized application and network support.

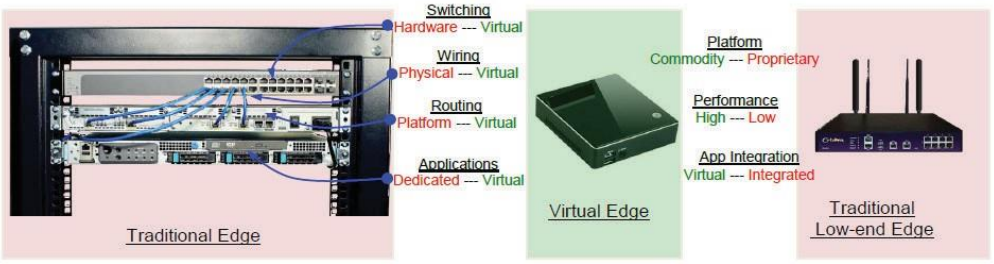


Figure 8 – Tradition to Virtual Evolution

In order to scale, once a single platform has maximized the number of applications that it runs, it is only necessary to add a second (or third, etc.) platform. This will hold true for most full-size applications, such as web services, databases, file systems, etc., that can inherently take advantage of multiple instances. Furthermore, it is possible to move VMs from one platform to the next in order to optimize the resources of a particular application on a particular platform.

> “iPhotonix’s MicroCloud concept aims to provide the same kind of agility in service features, immunity from box change-outs, and COTS hosting that NFV aims to provide overall, but with what might be two important differences—customer specificity and SDN integration ... “
>
> Tom Nolle, President of CIMI Corporation and Chief Architect for the CloudNFV project

BENEFITS:

Virtualization in the data center has demonstrated real-world scalability and optimization for applications much more effectively than traditional dedicated platforms. These same attributes will also hold true for edge virtualization.

Edge Virtualization Feature Example: "Survivability and Performance"

VIRTUALIZATION FEATURE OVERVIEW:

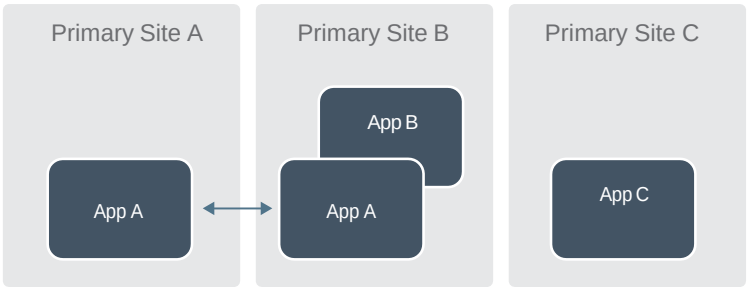


Figure 9 – Survivability & Performance

Virtualization not only yields a performance benefit, but also greatly simplifies and improves survivability and distribution (yielding further performance benefits). Survivability in a virtual environment means that even if any application(s) fail(s), the

hypervisor operating system, virtual machines, or other applications do not fail. Applications can be "spun" up in sub-second times when events cause an application, platform, or site failure. Additionally, because of network virtualization, these applications can be distributed across geographies both from a survivability and performance perspective.

EXAMPLE DESCRIPTION:

From a performance perspective, traditional edge solutions have relied on proprietary and purpose-built hardware, resulting in high costs and underperformance. On the very low end of traditional edge solutions, most hardware is ARM-based, with minimal memory and storage. These solutions typically are purpose-built and rely on open-source applications

with a small amount of software integration. Consequently, they are almost never capable of supporting the required performance of commercial or high-end applications. Additionally, because of their singular focus, they tend to be stand-alone devices incapable of surviving any type of failure. Two concrete examples running on the same platform are SDN-based networking and elastic cloud backup. The following figure represents these examples:

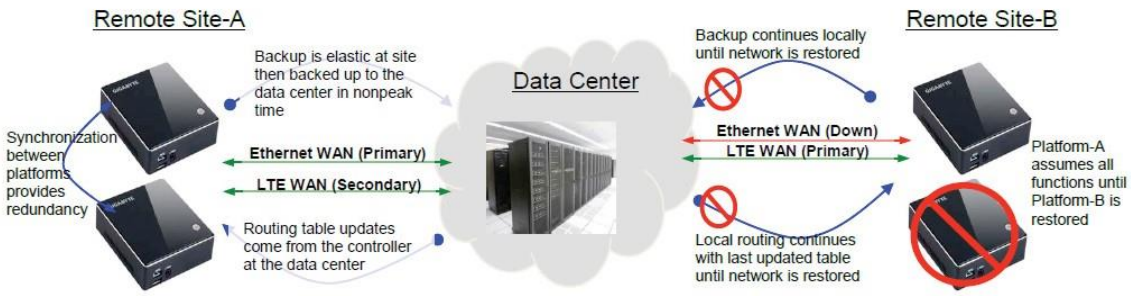


Figure 10 – Network & Backup Survivability

In the diagram, there are several points of survivability: 1) loss of connectivity to the data center, 2) platform loss, and 3) primary network loss. In each case the survivability components allow operations to continue, albeit at a reduced level (e.g., LTE speeds vs. Ethernet, routing with no updates, etc.).

BENEFITS:

Virtualization (platform and network) yields multiple levels of survivability and performance that are difficult to attain with traditional dedicated platforms.

Conclusion

Edge virtualization or MicroClouds, can provide enterprises and SMBs with efficiencies that legacy, purpose-built appliances cannot even begin to achieve. The better management of application resources, simpler policy administration, automated application integration and orchestration, and improved scalability, survivability, and performance all lead to significant and measurable cost savings.

Managed service providers and distributed enterprises would both benefit from deploying an edge virtualization strategy. In an example use case scenario of 50 sites where MicroClouds were deployed, there was a 3:1 up-front CAPEX savings and a 5:1 average OPEX savings over 3 years.

The iPhotonix Edge virtualization and SDN PON access solutions are here today and ready for production deployments. Integrating them into today's communications service providers environments will establish a foundation for a more efficient, optimized and manageable network over the long term.

About iPhotonix

iPhotonix is a Richardson, Texas based company and is the leading emerging technology provider for the optical access transformation occurring throughout the globe in the residential, business, enterprise and mobile backhaul markets. iPhotonix develops and markets via its iVolve brand, the world's first Multi-System Operable Optical Access Platform. This platform utilizes its own complete and comprehensive array of GPON and Active Ethernet access devices (ONTs, MDUs, RGs, etc.) and delivers the richest feature set of integrated voice, video, high-speed data and gateway solutions. iPhotonix augments its optical access offering with its powerful and agile iPhotonix Virtual Network (iVN) platform that enables communication service providers to create network managed services for a fraction of the cost and time it takes to deploy traditional managed services. iPhotonix has a rich history of innovation, R&D experience and delivering reliable solutions for communication services providers.

To discover how iPhotonix can light up and virtualize your network, visit www.iphotonix.com

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