Microsoft

Why Hyper-V?

Competitive Advantages of Microsoft Hyper-V Server 2012 over the VMware vSphere Hypervisor

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Windows Server

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Copyright information

Beyond Virtualization

Server virtualization has evolved over the past few years from a nascent technology, into a mature IT feature. In the process, businesses of all sizes have begun taking advantage of its power to meet shifting business needs. By virtualizing their workloads, organizations can control and cut costs while improving the scalability, flexibility, and reach of IT systems.

With these advances, however, comes the realization that virtualization by itself does not allow organizations to build or take advantage of cloud services, which are assuming an ever-growing role in the execution of business tasks.

First introduced as part of Windows Server 2008, expanded and enhanced in Windows Server 2008 R2, and enhanced still further with Windows Server 2012, Hyper-V provides organizations with a tool for optimizing server hardware investments by consolidating multiple server roles as separate virtual machines running on a single physical host machine.

Introducing Microsoft Hyper-V Server

In addition to the Hyper-V role found within Windows Server, Microsoft also released a separate edition of Hyper-V, namely, Microsoft Hyper-V Server. Microsoft Hyper-V Server is a hypervisor-based server virtualization product that enables organizations to consolidate workloads, improving server utilization and reduce costs. Microsoft Hyper-V Server is a dedicated, no-cost, standalone product that contains the hypervisor, Windows Server driver model, virtualization capabilities, and supporting components such as failover clustering, but does not contain the robust set of features and roles that the full Windows Server operating system has. As a result, Microsoft Hyper-V Server has a small footprint and minimal overhead.

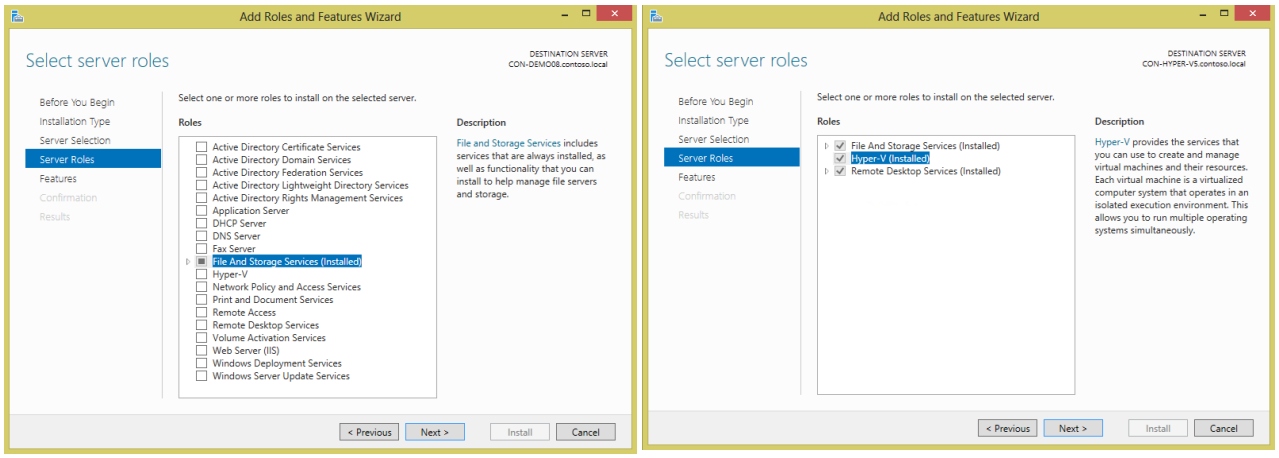

Figure 1 – Comparison of Server Roles available in Windows Server 2012 (left) and Microsoft Hyper-V Server 2012 (Right)

One of the most common uses for Microsoft Hyper-V Server 2012 is in Virtual Desktop Infrastructure (VDI) environments. VDI allows a Windows client operating system to run on server-based virtual machines in the datacenter, which the user can access from a PC, thin client, or other client device. A full client environment is virtualized within a server-based hypervisor, centralizing users' desktops.

By deploying VDI with Microsoft Hyper-V Server 2012, users will have seamless access to a rich, full fidelity Windows environment running in the data center, from any device. Microsoft Hyper-V Server 2012 also gives IT professionals a cost effective VDI solution with simplified administration, flexible storage options, and dynamic allocation of resources.

It's important to note that Microsoft Hyper-V Server 2012 doesn't include any Guest Operating System licenses. Customers who wish to download and use Microsoft Hyper-V Server 2012 for their key workloads will need to license their virtualized workloads accordingly. For customers who have existing investments in Windows Server, either current, or legacy, these licenses could be reassigned onto the new Hyper-V Server 2012 hosts. More information on Windows Server 2012 licensing can be found here: http://www.microsoft.com/licensing/about-licensing/windowsserver2012.aspx. Hyper-V Server 2012 is also a great virtualization platform for Linux, supporting a significant number of different Linux distributions.

Before Microsoft Hyper-V Server 2012

Let's first review the Hyper-V improvements that the earlier versions of Microsoft Hyper-V Server provide. Microsoft Hyper-V Server was first introduced in October 2008, significantly enhanced with the R2 update in August 2009, with additional capabilities being added with SP1 in February 2011.

Microsoft Hyper-V Server 2008 R2 Hyper-V Enhancements

With the launch of Microsoft Hyper-V Server 2008 R2, Microsoft introduced a number of compelling capabilities to help organizations reduce costs, whilst increasing agility and flexibility, all at no cost. Key features introduced included:

- **Live Migration** – Enabling the movement of virtual machines (VMs) with no interruption or downtime
- **Cluster Shared Volumes** – Highly scalable and flexible use of shared storage (SAN) for VMs
- **Processor Compatibility** – Increase the Flexibility for Live Migration across hosts with differing CPU architectures
- **Hot Add Storage** – Flexibly add or remove storage to and from VMs
- **Improved Virtual Networking Performance** – Support for Jumbo Frames and Virtual Machine Queue (VMq)

With the addition of Service Pack 1 (SP1) for Microsoft Hyper-V Server 2008 R2, Microsoft introduced 2 new, key capabilities to help organizations realize even greater value from the platform:

- **Dynamic Memory** – More efficient use of memory while maintaining consistent workload performance and scalability.
- **RemoteFX** – Provided the richest virtualized Windows 7 experience for Virtual Desktop Infrastructure (VDI) deployments.

Microsoft Hyper-V Server 2008 R2 Hyper-V Benefits

With Microsoft Hyper-V Server R2, customers get a compelling solution for core virtualization scenarios; production server consolidation, dynamic data center, business continuity, Virtual Desktop Infrastructure (VDI), and test and development. Hyper-V provides customers with better flexibility with features like live migration and cluster shared volumes for storage flexibility. In the 2008 R2 release, Microsoft Hyper-V Server also delivered greater scalability with support for up to 64 logical processors and improved performance with support for dynamic memory and enhanced networking support.

Why Hyper-V?

Virtualization technologies help customers' lower costs and deliver greater agility and economies of scale. Either as a stand-alone product or an integrated part of Windows Server, Hyper-V is an incredibly compelling, feature-rich virtualization platform for today and the transformational opportunity with cloud computing.

With Hyper-V, it is now easier than ever for organizations to take advantage of the cost savings of virtualization, and make the optimum use of server hardware investments by consolidating multiple server roles as separate virtual machines that are running on a single physical machine. Customers can use Hyper-V to efficiently run multiple operating systems, Windows, Linux, and others, in parallel, on a single server. Microsoft Hyper-V Server 2012 extends this with more features, greater scalability and further inbuilt reliability mechanisms.

In the data center, on the desktop, and now in the cloud, the Microsoft virtualization platform, which is led by Hyper-V and management tools, simply makes more sense and offers better value for money when compared to the competition.

This paper will focus on comparing Microsoft Hyper-V Server 2012, with the standalone VMware vSphere Hypervisor, also known as ESXi, across 4 key areas:

- Scalability, Performance & Density
- Secure Multitenancy
- Flexible Infrastructure
- High Availability & Resiliency

Are all free hypervisors created equal?

As we outlined earlier, Microsoft Hyper-V Server 2012 does not contain the robust set of features and roles that the full Windows Server 2012 operating system has, however, from a pure Hyper-V perspective, Microsoft Hyper-V Server 2012 has feature parity with the feature set of Windows Server 2012 Hyper-V, meaning customers can take advantage of the same high levels of scalability and performance, and the rich feature set, without additional host system licensing costs. This means customers of all shapes and sizes, from the smallest SMB customers, to the largest enterprises, have access to the same rich feature set and long list of powerful capabilities that are in the box with Microsoft Hyper-V Server 2012.

This is a stark contrast to the free, standalone offering from VMware. The vSphere Hypervisor, sometimes known as ESXi, is positioned by VMware as the "simplest and easiest way to get started with virtualization for free. This free edition is a fully functional hypervisor that lets you virtualize your servers and run your applications in virtual machines in a matter of minutes", and has been designed to enable organizations to not only run multiple applications on a single server, but also reduce energy costs, ensure backup and recovery is simpler and more efficient, and unlock the ability to virtualize even the most mission-critical of workloads.

In reality however, the free VMware vSphere Hypervisor loses many of the features that exist in the paid-for vSphere editions. Customers lose agility, with no ability to move running workloads. Customers lose scalability, with host servers capped at 32GB of physical memory. Customers lose resiliency, with no high-

availability for workloads. These are just three examples, and as we go forward in the report, we'll see there are a significant number of missing capabilities when compared with Microsoft Hyper-V Server 2012.

Scalability, Performance & Density

Microsoft Hyper-V Server 2008 R2 supported configuring virtual machines with a maximum of four virtual processors and up to 64 GB of memory. However, IT organizations increasingly want to use virtualization when they deploy mission-critical, tier-1 business applications. Large, demanding workloads such as online transaction processing (OLTP) databases and online transaction analysis (OLTA) solutions typically run on systems with 16 or more processors and demand large amounts of memory. For this class of workloads, more virtual processors and larger amounts of virtual machine memory are a core requirement.

Hyper-V Server 2012 greatly expands support for host processors and memory. New features include support for up to 64 virtual processors and 1TB of memory for Hyper-V guests, a new VHDX virtual hard disk format with larger disk capacity of up to 64 TB, and additional resiliency. These features help ensure that the virtualization infrastructure can support the configuration of large, high-performance virtual machines to support workloads that might need to scale up significantly.

These however, aren't the only improvements in Microsoft Hyper-V Server 2012, as you can see from the table below:

	Resource	Microsoft Hyper-V Server 2008 R2	Microsoft Hyper-V Server 2012	Improvement Factor
Host	Logical Processors	64	**320**	**5×**
	Physical Memory	1TB	**4TB**	**4×**
	Virtual CPUs per Host	512	**2,048**	**4×**
VM	Virtual CPUs per VM	4	**64**	**16×**
	Memory per VM	64GB	**1TB**	**16×**
	Active VMs per Host	384	**1,024**	**2.7×**
	Guest NUMA	No	**Yes**	**-**
Cluster	Maximum Nodes	16	**64**	**4×**
	Maximum VMs	1,000	**8,000**	**8×**

Significant improvements have been made across the board, with Microsoft Hyper-V Server 2012 now supporting increased cluster sizes, a significantly higher number of active virtual machines per host, and additionally, more advanced performance features such as in-guest Non-Uniform Memory Access (NUMA). This ensures customers can achieve the highest levels of scalability, performance and density for their mission-critical workloads.

How does VMware Compare?

The table below shows a comparison between Microsoft Hyper-V Server 2012, and the VMware vSphere Hypervisor.

	Resource	Microsoft Hyper-V Server 2012	VMware vSphere Hypervisor
Host	Logical Processors	**320**	160
	Physical Memory	**4TB**	32GB
	Virtual CPUs per Host	**2,048**	2,048
VM	Virtual CPUs per VM	**64**	8
	Memory per VM	**1TB**	32GB
	Active VMs per Host	**1,024**	512
	Guest NUMA	**Yes**	Yes
Cluster	Maximum Nodes	**64**	N/A
	Maximum VMs	**8,000**	N/A

The table shows that Microsoft Hyper-V Server 2012 offers significantly greater scale across Host, VM and Cluster when compared with the VMware vSphere Hypervisor. As we mentioned, VMware positions the vSphere Hypervisor as simple, entry-level solution designed to allow users to experience the benefits of VMware's virtualization platform at no cost, however on closer examination, certain restrictions are imposed which prevent customers utilizing the solution at scale, meaning customers have to purchase, at significant cost, one of the more advanced vSphere editions. Examples of this include the capping of physical memory on the vSphere Hypervisor to 32GB, limiting scalability, and subsequently maximum virtual machine memory size as a result. This 32GB limitation isn't just a soft limitation, where the hypervisor simply won't use more than 32GB if you have more in the host. On the contrary, it's a hard, physical block, with the vSphere Hypervisor unable to accept the free license key if the host has greater than 32GB of memory. Microsoft Hyper-V Server 2012 has no such restrictions or blocks.

Since the launch of vSphere 5.0, in 2011, VMware has regularly discussed the inclusion of 32 virtual processors within a virtual machine, yet this was exclusive to the Enterprise Plus edition of vSphere, and not the vSphere Hypervisor, vSphere 5.0 Essentials, Essentials Plus, Standard, and Enterprise editions, which were all capped at 8 virtual processors per virtual machine. With vSphere 5.1 however, the Enterprise edition can now support VMs with up to 32 vCPUs, and the Enterprise Plus edition, 64 vCPUs. The vSphere Hypervisor however, is still capped at 8 vCPUs. Compare this with Microsoft Hyper-V Server 2012, which, with support for 64 vCPUs in the box, enables customers to run the most demanding of their workloads without additional costs or edition upgrades. The table also shows that Microsoft Hyper-V Server 2012 delivers up to 1TB of memory to an individual virtual machine. When compared with VMware, due to the fact that the vSphere Hypervisor is physically capped at 32GB memory, this significantly restricts the amount of memory that a VM can actually utilize. From an individual host perspective, Hyper-V also supports double the number of active virtual machines per host customers can realize even greater levels of density for their key workloads, whilst achieving a better return on investment.

Whilst virtualization itself is an incredibly important aspect within the datacenter, resiliency and high availability of workloads is of equal importance. The inclusion of Failover Clustering with Microsoft Hyper-V Server 2012 enables customers to achieve massive scale with an unparalleled number of nodes within a cluster, and virtual machines per cluster. Unfortunately, the VMware vSphere Hypervisor alone doesn't

provide any high availability, or resiliency features, and customers must purchase vSphere 5.1 to unlock these features, and even then, cluster sizes are restricted to only 32 nodes, and 4,000 virtual machines per cluster, which is considerably smaller than the 64 nodes, and 8,000 VMs supported by Microsoft Hyper-V Server 2012.

Enhanced Storage Capabilities

Microsoft Hyper-V Server 2012 also introduces a number of enhanced storage capabilities to support the most intensive, mission-critical of workloads. These capabilities include:

- **Virtual Fiber Channel** – Enables virtual machines to integrate directly into Fiber Channel Storage Area Networks (SAN), unlocking scenarios such as fiber channel-based Hyper-V Guest Clusters.
- **Support for 4-KB Disk Sectors in Hyper-V Virtual Disks.** Support for 4,000-byte (4-KB) disk sectors lets customers take advantage of the emerging innovation in storage hardware that provides increased capacity and reliability.
- **New Virtual Hard Disk Format.** This new format, called VHDX, is designed to better handle current and future workloads and addresses the technological demands of an enterprise's evolving needs by increasing storage capacity, protecting data, improving quality performance on 4-KB disks, and providing additional operation-enhancing features. The maximum size of a VHDX file is 64TB.
- **Offloaded Data Transfer (ODX).** With Offloaded Data Transfer support, the Hyper-V host CPUs can concentrate on the processing needs of the application and offload storage-related tasks to the SAN, increasing performance.
- **Boot from USB Disk**. With its reduced footprint, Microsoft Hyper-V Server 2012 supports installation to USB media, providing more deployment flexibility, especially in scenarios such as diskless servers.
- **Storage Spaces**. Storage Spaces transform SAS & SATA disks into storage pools, from which logical disks, or Storage Spaces, can then be provisioned. These Storage Spaces can be given different levels of resiliency and performance, can be thinly or fully provisioned, and support advanced features such as trim provisioning. Storage Spaces enable you to deliver a new category of highly capable storage solutions to all Windows customer segments at a dramatically lower price point. At the same time, you can maximize your operations by leveraging commodity storage to supply high-performance and feature-rich storage to servers, clusters, and applications alike.

How does VMware compare?

Capability	Microsoft Hyper-V Server 2012	VMware vSphere Hypervisor
Virtual Fiber Channel	**Yes**	Yes
3rd Party Multipathing (MPIO)	**Yes**	No
Native 4-KB Disk Support	**Yes**	No
Maximum Virtual Disk Size	**64TB VHDX**	2TB VMDK
Maximum Pass Through Disk Size	**256TB+**	64TB
Offloaded Data Transfer	**Yes**	No
Boot from USB Disk	**Yes**	Yes
Storage Pooling	**Yes**	No

As shown in the table, Microsoft Hyper-V Server 2012 provides a significant number of advantages over the vSphere Hypervisor. Customers building virtualized infrastructures today require the highest levels of availability and performance, and wish to maximize the investment in their chosen technologies to help drive their business forward. With Microsoft, the ability to utilize Device Specific Modules, also known as DSMs, produced by storage vendors, in conjunction with the Multipath I/O framework within Windows Server 2012 & Microsoft Hyper-V Server 2012, ensures that customers run their workloads on an optimized configuration from the start, as the storage vendor intended, providing the highest levels of performance and availability. This framework is built into the platform, at no cost. Unfortunately, the vSphere Hypervisor doesn't provide the ability to utilize these storage vendor specific optimizations, and in fact, only the Enterprise and Enterprise Plus editions of vSphere 5.1, through a feature known as 'vStorage APIs for Multipathing', provide this capability, meaning customers have to upgrade to higher, more costly editions in order to unlock the best performance from their storage investments.

When implementing a virtualized infrastructure, customers today look to the future to understand new technology trends and innovations that are coming down the line. One of those innovations is the rapidly emerging Advanced Format Disks, which have a 4KB physical sector size. These disks bring an increase in performance, and are natively supported by Microsoft Hyper-V Server 2012, but unfortunately, are not supported with the vSphere Hypervisor and vSphere 5.1, restricting future hardware upgrades.

As customers introduce larger, more powerful workloads into their virtual environments, the amount of data associated with these workloads, over time, will grow. Fortunately, Microsoft Hyper-V Server 2012 supports the creation of virtual disks, quickly and efficiently, of up to 64 Terabytes (TB) in size, allowing huge databases, file repositories or document archives to be stored within individual disks.

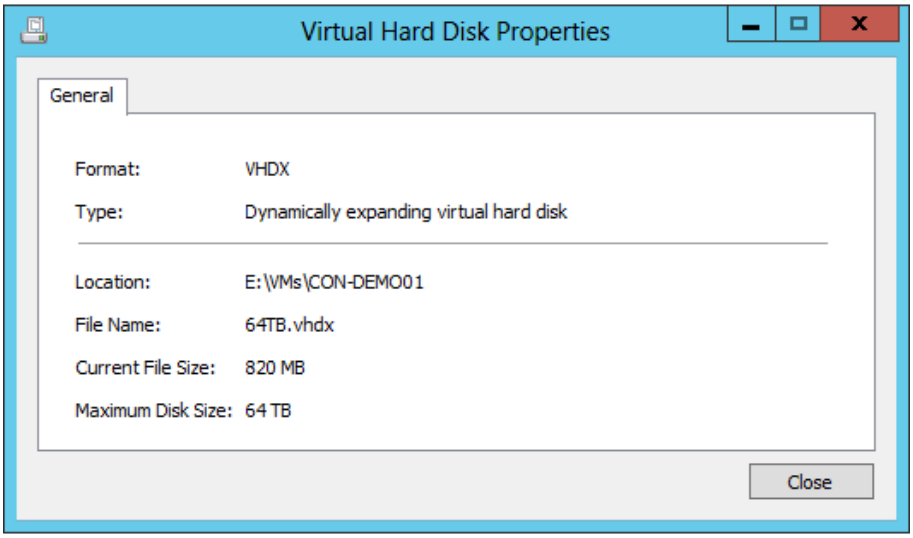

Figure 2 – a Hyper-V Virtual Hard Disk configured with 64TB capacity

Whilst VMware's proprietary file system, VMFS5, supports datastore sizes of 64TB, the Virtual Machine Disk Format (VMDK), is restricted to 2TB, meaning customers have to utilize the less flexible, less portable Raw Device Mappings (RDMs). If customers do choose to implement RDMs, 64TB is the maximum supported size, however with Microsoft Hyper-V Server 2012, there are no specific maximum limits on the size of a pass through disk. The maximum size of a physical disk attached to a virtual machine is ultimately determined by what the guest operating system supports, with more recent Windows Server operating systems supporting individual disk sizes of over 256TB. This ensures that the largest data-driven workloads can be virtualized on Hyper-V with ease.

We mentioned earlier, a capability known as 3rd Party Multipathing, and how this enables customers to optimize their Host-to-SAN integration and connectivity, maximizing their investment in both of these key elements of the virtualized infrastructure, and providing the highest levels of performance and availability for their critical workloads. Offloaded Data Transfer (ODX), a key capability of Microsoft Hyper-V Server 2012, is another of those features that enables organizations to maximize their investment in their current technologies. By integrating Microsoft Hyper-V Server 2012 with an ODX-capable storage array, many of the storage-related tasks that would normally use valuable CPU and network resources on the Hyper-V hosts, are offloaded to the array itself, executing much faster, increasing performance significantly, and unlocking extra resources on the hosts themselves. VMware offer a similar capability, known as vStorage APIs for Array Integration, VAAI, but unfortunately, this capability is only available in the Enterprise and Enterprise Plus editions of vSphere 5.1, meaning customers, again, have to upgrade to higher editions to achieve higher performance from their hardware investments.

Both Microsoft Hyper-V Server 2012 and the VMware vSphere Hypervisor support deployment to USB media, to unlock scenarios such as diskless servers, but for organizations who do wish to retain disks, either spinning or flash-based, inside their hypervisor hosts, Microsoft Hyper-V Server 2012, with Storage Spaces, has significant advantages over the VMware vSphere Hypervisor. Storage Spaces will enable a customer to maximize their investment in their hardware by transforming those disks into a storage pool, and from there, provision Storage Spaces on which the Hyper-V VMs can run. These Storage Spaces can be thinly provisioned to help maximize utilization, and can use mirroring or parity to increase resiliency. Also, with trim provisioning, when a large file gets deleted from one of the VMs, the VMs communicate this to the host and the host down to Storage Spaces and Spaces will automatically reclaim this storage and assign it to other disks within the same pool or other pools. So you are optimizing storage utilization with on-demand provisioning and automated capacity reclamation. VMware provide nothing similar in the vSphere Hypervisor.

Enhanced Resource Management

Microsoft Hyper-V Server 2012 also introduces a number of enhanced resource management capabilities that include:

- **Dynamic Memory Improvements -** These improvements dramatically increase virtual machine consolidation ratios and improve reliability for restart operations that can lead to lower costs, especially in environments, such as VDI, that have many idle or low-load virtual machines.
- **Resource Metering -** Resource Metering provides the ability to track and report the amount of data that is transferred per IP address or virtual machine to help ensure accurate chargebacks.
- **Quality of Service -** QoS provides the ability to programmatically adhere to a service level agreement (SLA) by specifying the minimum bandwidth that is available to a virtual machine or a port. It prevents latency issues by allocating maximum bandwidth use for a virtual machine or port.
- **Data Center Bridging (DCB) -** DCB takes advantage of the latest innovations and reduces the cost and difficulty to maintain separate network, management, live migration and storage traffic by using a modern, converged 10-gigabit local area network (LAN).

How does VMware Compare?

Capability	Microsoft Hyper-V Server 2012	VMware vSphere Hypervisor
Dynamic Memory	**Yes**	Yes
Resource Metering	**Yes**	Yes
Quality of Service	**Yes**	No
Data Center Bridging (DCB)	**Yes**	Yes

As shown in the table, when it comes to memory management, Microsoft Hyper-V Server 2012, along with the VMware vSphere Hypervisor, both provide techniques to better utilize virtual machine memory, increase density and maximize return on investment, however Microsoft's approach to memory management is different to that of VMware. VMware claim, that through their 4 memory management techniques; Memory Ballooning, Transparent Page Sharing, Compression and Swapping, they can provide a virtual machine density greater than that of Hyper-V, yet in reality, this is false. All 4 of these memory management techniques only operate when the host is under memory pressure, heavily laden, as a reactive measure. With technologies such as Transparent Page Sharing (TPS), with the majority of hardware platforms now supporting higher performance 2MB Large Page Tables by default (LPT), TPS is unable to deduplicate memory pages as easily as it would, prior to LPT, thus the capability becomes significantly less useful. Under memory pressure, the vSphere Hypervisor host will break down large memory pages into smaller, 4KB pages, which it can then deduplicate, freeing up memory, but unfortunately, this process doesn't occur without a cost to already limited, host performance. With compression and swapping, whilst both help to keep virtual machines operable, it's too little too late, with performance of key workloads at this point, becoming severely degraded.

With Dynamic Memory, Hyper-V works intuitively with the guest operating system, delivering, and reclaiming memory from the virtual machine in a way that is optimal for the guest operating system, ensuring resources are provided appropriately, and a consistent level of performance is achieved for key workloads, ultimately providing the highest levels of density, and the greatest return on investment.

As we move towards more cloud-oriented infrastructures, especially in multi-tenanted environments, hosting providers and enterprises must be able to measure the amount of data center resources (compute, network, and storage) that are consumed by each workload. These can be used to charge external customers (known as chargeback), or for internal accounting (known as showback) for cross-departmental budget management scenarios of an enterprise. Resource Metering, which is a standard feature of Microsoft Hyper-V Server 2012, when combined with new performance counters, exposes a wealth of information from which chargeback and showback models can be built. While the VMware vSphere Hypervisor enables the capturing of information within the vSphere Client, it's on a single host by host basis, and organizations must move to vSphere 5.1, and, at additional cost to vSphere 5.1, purchase vCenter Chargeback Manager, in order utilize the information in a centralized, meaningful manner.

Whilst chargeback and showback are two important elements for a private cloud, ensuring service levels are met is equally important, whether the primary business is that of a hosting provider, serving external customers, or an enterprise organization, serving internal business units with chargeable resources. Either way, ensuring the highest levels of performance is imperative and with Microsoft Hyper-V Server 2012, Quality of Service (QoS) is a standard feature, enabling organizations to ensure that Service Level Agreements (SLAs) for key workloads are met, and at the same time, intensive virtual machines don't consume more than their allocated allowance.

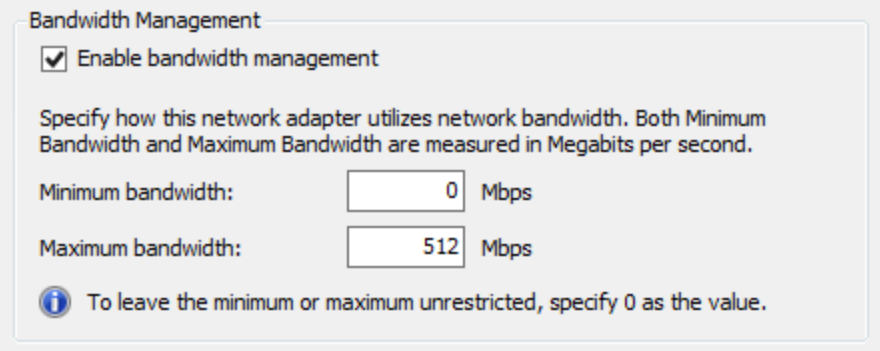

Figure 3 – QoS enabled on a Hyper-V virtual machine's network adaptor

With VMware however, QoS isn't available in the vSphere Hypervisor. In fact, it's only available in the Enterprise Plus edition of vSphere 5.1, so for those customers who wish to implement stringent SLAs, customers must upgrade, at additional cost, to VMware's highest edition.

Security and Multitenancy

Virtualized data centers are becoming more popular and practical every day. IT organizations and hosting providers have begun offering infrastructure as a service (IaaS), which provides more flexible, virtualized infrastructures to customers—"server instances on-demand." Because of this trend, IT organizations and hosting providers must offer customers enhanced security and isolation from one another.

If a service provider's infrastructure is hosting two companies, the IT Admin must help ensure that each company is provided its own privacy and security. Before Microsoft Hyper-V Server 2012, server virtualization provided isolation between virtual machines, but the network layer of the data center was still not fully isolated and implied layer-2 connectivity between different workloads that run over the same infrastructure.

For the hosting provider, isolation in the virtualized environment must be equal to isolation in the physical data center, to meet customer expectations and not be a barrier to cloud adoption.

Isolation is almost as important in an enterprise environment. Although all internal departments belong to the same organization, certain workloads and environments (such as finance and human resource systems) must still be isolated from each other. IT departments that offer private clouds and move to an IaaS operational mode must consider this requirement and provide a way to isolate such highly sensitive workloads.

Microsoft Hyper-V Server 2012 contains new security and isolation capabilities through the Hyper-V Extensible Switch.

The Hyper-V Extensible Switch

With Microsoft Hyper-V Server 2012, the IT Admin can configure Hyper-V servers to enforce network isolation among any set of arbitrary isolation groups, which are typically defined for individual customers or sets of workloads.

Microsoft Hyper-V Server 2012 provides the isolation and security capabilities for multitenancy by offering the following new features:

- **Private VLANS (PVLANS)** - Provide isolation between two virtual machines on the same VLAN

- **ARP/ND Poisoning/Spoofing** - Protection against a malicious virtual machine stealing IP addresses from other virtual machines
- **DHCP Snooping/DHCP Guard** - Protects against rogue DHCP servers attempting to provide IP addresses that would cause traffic to be rerouted
- **Virtual Port ACLs** - Isolate networks and metering network traffic for a virtual port
- **Trunk Mode to Virtual Machines** - Traffic from multiple VLANs can now be directed to a single network adapter in a virtual machine
- **Monitoring & Port Mirroring** - Monitor the traffic from specific ports flowing through specific virtual machines on the switch and mirror traffic which can then be delivered to another virtual port for further processing
- **Windows PowerShell/Windows Management Instrumentation (WMI)** - Provides Windows PowerShell cmdlets for the Hyper-V Extensible Switch that lets customers and partners build command-line tools or automated scripts for setup, configuration, monitoring, and troubleshooting

Extending the Extensible Switch

Many enterprises need the ability to extend virtual switch features with their own plug-ins to suit their virtual environment. If you're in charge of making IT purchasing decisions at your company, you want to know that the virtualization platform you choose won't lock you in to a small set of compatible features, devices, or technologies.

In Microsoft Hyper-V Server 2012 the Hyper-V Extensible Switch provides new extensibility features. The Hyper-V Extensible Switch is a layer-2 virtual network switch that provides programmatically managed and extensible capabilities to connect virtual machines to the physical network. The Hyper-V Extensible Switch is an open platform that lets multiple vendors provide extensions that are written to standard Windows API frameworks. The reliability of extensions is strengthened through the Windows standard framework and reduction of required third-party code for functions and is backed by the Windows Hardware Quality Labs (WHQL) certification program. The IT Admin can manage the Hyper-V Extensible Switch and its extensions by using Windows PowerShell, programmatically with WMI or through the Hyper-V Manager user interface.

Several Partners have already announced extensions for the Hyper-V Extensible Switch, including:

- **Cisco -** Nexus 1000V Series Switches & UCS Virtual Machine Fabric Extender (VM-FEX)
- **NEC -** OpenFlow
- **5nine –** Security Manager
- **InMon -** sFlow

How does VMware compare?

Capability	Microsoft Hyper-V Server 2012	VMware vSphere Hypervisor
Extensible Network Switch	**Yes**	No
Confirmed Partner Extensions	**5**	No
Private Virtual LAN (PVLAN)	**Yes**	No
ARP/ND Spoofing Protection	**Yes**	No
DHCP Snooping/DHCP Guard	**Yes**	No
Virtual Port ACLs	**Yes**	No
Trunk Mode to Virtual Machines	**Yes**	No
Port Monitoring	**Yes**	Per Port Group
Port Mirroring	**Yes**	Per Port Group

Whilst VMware offer an advanced distributed network switch, known as the vSphere Distributed Switch. Unfortunately, it is only available in the Enterprise Plus edition of vSphere 5.1, thus customers wishing to take advantage of the increased granularity, management capability and control, have to upgrade to the highest edition, at substantial cost. The VMware vSphere Hypervisor, unfortunately doesn't provide this capability and thus lacks the more advanced security and isolation capabilities.

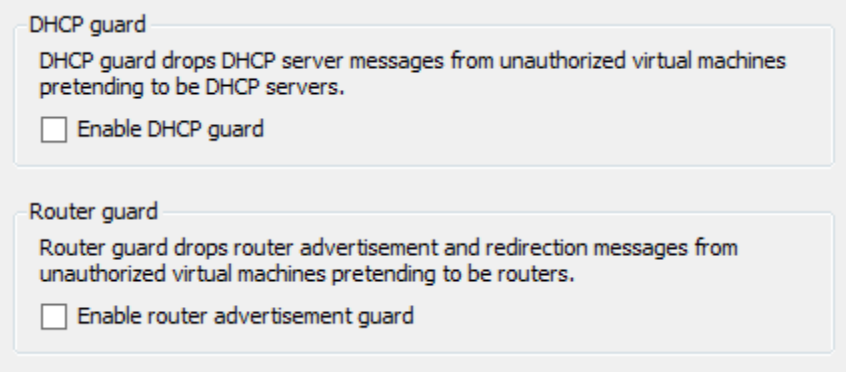

Figure 4 – Two examples of the advanced security capabilities provided by the Hyper-V Extensible Switch

With Microsoft Hyper-V Server 2012, the networking switch is completely extensible, already with commitment from 4 Partners; Cisco, NEC, 5nine and InMon, to deliver extended functionality across a variety of different extension types, from packet inspection and filtering through to forwarding and intrusion detection, offering customers a greater set of choice for their specific environment. With System Center 2012 SP1 Virtual Machine Manager, customers are able to centrally control and manage the Hyper-V extensible switches across all hosts, providing greater control, and simplified management for larger environments.

Due to this lack of advanced networking switch in the VMware vSphere Hypervisor, many of the more advanced networking capabilities within Microsoft Hyper-V Server 2012 are unfortunately not present within the free VMware vSphere Hypervisor, and even with vSphere 5.1, key security protection capabilities such as ARP and ND Spoofing Protection, DHCP Snooping Protection and DHCP Guard, along with Virtual Port Access Control Lists are only available through the purchase of additional technologies on top of vSphere 5.1; either the App component of the vCloud Networking & Security (vCNS) product (formerly

vShield App) or within the network switch technologies from vendors such as Cisco. This means that again, customers have to add additional, costly technologies in order to provide protection from these threats.

With the Hyper-V Extensible Switch trunk mode, traffic from multiple VLANs can now be directed to a single network adapter in a virtual machine that could previously receive traffic from only one VLAN. As a result, traffic from different VLANs is consolidated, and a virtual machine can listen in on multiple VLANs. This feature can help the IT Admin shape network traffic and enforce multitenant security in the data center. Unfortunately, this feature isn't available in vSphere Hypervisor, meaning customers have to upgrade to a higher edition in order to take advantage of the additional level of configuration granularity.

Finally, the Hyper-V Extensible Switch provides organizations with the ability to not only monitor individual ports within a vSwitch, but also mirror the traffic that is passing, to an alternative location for further analysis. With the VMware vSphere Hypervisor however, all traffic on a Port Group or vSwitch, on which 'Promiscuous Mode' is enabled, is exposed, posing a potential risk to the security of that network. This lack of granularity restricts it's usage in real world environments, and means that customers who require this level of protection have to upgrade to vSphere 5.1 Enterprise Plus, which has the Distributed Switch technology to provide the capability through features such as NetFlow and Port Mirroring.

Networking Performance Enhancements

Microsoft Hyper-V Server 2012 also includes a number of performance enhancements within the networking stack to help customers virtualize their most intensive workloads. Virtual Machine Queue, introduced in Windows Server 2008 R2 Hyper-V, enables, when combined with VMq-capable network hardware, a more streamlined and efficient delivery of packets from the external network to the virtual machine, reducing the overhead on the host operating system. In Microsoft Hyper-V Server 2012 however, this has been streamlined and performance improved considerably, with Dynamic Virtual Machine Queue spreading the processing of the network traffic more intelligently across CPUs in the host, resulting in higher networking performance.

When it comes to security, many customers are familiar with IPsec. IPsec protects network communication by authenticating and encrypting some, or all of the contents of network packets. IPsec Task Offload in Microsoft Hyper-V Server 2012 leverages the hardware capabilities of server NICs to offload IPsec processing. This reduces the CPU overhead of IPsec encryption and decryption significantly.

In Microsoft Hyper-V Server 2012, IPsec Task Offload is extended to Virtual Machines as well. Customers using VMs who want to protect their network traffic with IPsec can take advantage of the IPsec hardware offload capability available in server NICs, thus freeing up CPU cycles to perform more application-level work and leaving the per packet encryption/decryption to hardware.

Finally, when it comes to virtual networking, a primary goal is native I/O throughput. Microsoft Hyper-V Server 2012 adds the ability to assign SR-IOV functionality from physical devices directly to virtual machines. This gives VMs the ability to bypass the software-based Hyper-V Virtual Switch, and directly address the NIC. As a result, CPU overhead and latency is reduced, with a corresponding rise in throughput.

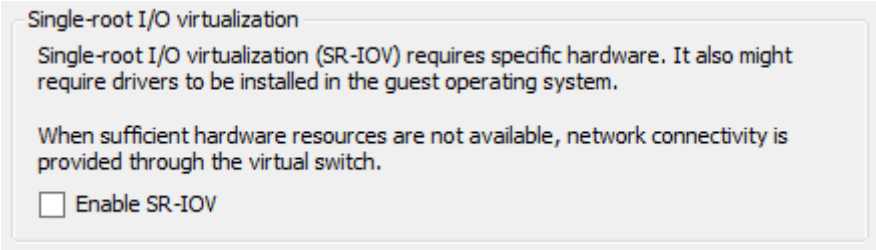

Figure 5 –SR-IOV, which provides a VM, and applications within it, higher networking performance

This is all available, without sacrificing key Hyper-V features such as virtual machine Live Migration.

How does VMware compare?

Capability	Microsoft Hyper-V Server 2012	VMware vSphere Hypervisor
Dynamic Virtual Machine Queue	**Yes**	NetQueue
IPsec Task Offload	**Yes**	No
SR-IOV with Live Migration	**Yes**	No

Whilst VMware provide a capability known as NetQueue, in VMware's own documentation, 'Performance Best Practices for VMware vSphere 5.0', it is noted that "*On some 10 Gigabit Ethernet hardware network adapters, ESXi supports NetQueue, a technology that significantly improves performance of 10 Gigabit Ethernet network adapters in virtualized environments*". What does this mean for customers who have servers that don't have 10 GigE? With Microsoft Hyper-V Server 2012, and D-VMq, customers with existing 1 gigabit **and** 10 gigabit Ethernet adaptors can flexibly utilize these advanced capabilities to improve performance and throughput, whilst reducing the CPU burden on their Hyper-V hosts.

When it comes to network security, specifically IPsec, VMware offers no offloading capabilities from the virtual machine through to the physical network interface, thus in a densely populated environment, valuable host CPU cycles will be lost to maintain the desired security level. With Microsoft Hyper-V Server 2012, the IPsec Task Offload capability will move this workload to a dedicated processor on the network adaptor, enabling customers to make dramatically better use of the resources and bandwidth that is available.

As stated earlier, when it comes to virtual networking, a primary goal is native I/O. With SR-IOV, customers have the ability to directly address the physical network interface card from within the virtual machine, reducing CPU overhead and latency whilst increasing throughput. In vSphere 5.1, VMware have introduced SR-IOV support, however it requires the vSphere Distributed Switch – a feature only found in the highest vSphere edition, meaning customers have to upgrade to take advantage of this higher levels of performance. Also, VMware's implementation of SR-IOV unfortunately doesn't support other features such as vMotion, High Availability and Fault Tolerance, meaning customers who wish to take advantage of higher levels of performance, must sacrifice agility and resiliency. Prior to vSphere 5.1, VMware provided a feature that offered a similar capability to SR-IOV, and continues to offer this in 5.1. DirectPath I/O, a technology which binds a physical network card to a virtual machine, offers that same enhancement, to near native performance, however, unlike SR-IOV in Microsoft Hyper-V Server 2012, a virtual machine with DirectPath I/O enabled is restricted to that particular host, unless the customer is running a certain configuration of Cisco UCS. Other caveats include:

- Very Small Hardware Compatibility List
- No Memory Overcommit
- No vMotion (unless running certain configurations of Cisco UCS)
- No Fault Tolerance
- No Network I/O Control
- No VM Snapshots (unless running certain configurations of Cisco UCS)
- No Suspend/Resume (unless running certain configurations of Cisco UCS)
- No VMsafe/Endpoint Security support

Whilst DirectPath I/O may be attractive to customers from a performance perspective, VMware ask customers to sacrifice agility, losing vMotion in most cases, and scale, having to disable memory overcommit, along with a number of other vSphere features.

No such restrictions are imposed when using SR-IOV with Microsoft Hyper-V Server 2012, ensuring customers can combine the highest levels of performance with the flexibility they need for an agile, scalable infrastructure.

Physical Security

When it comes to deployment of virtualization technologies, many are within secure datacenter environments, but what about those that aren't? Satellite offices, remote sites, home offices and retail stores are all examples of environments that may not have them same levels of physical security as the enterprise datacenter, yet may still have physical servers, with virtualization technologies present. If the physical hosts were compromised, there could be very serious repercussions for the business.

With Microsoft Hyper-V Server 2012, BitLocker Drive Encryption is included to solve that very problem, by allowing customers to encrypt all data stored on the operating system volume and configured data volumes, along with any Failover Cluster disks, including Cluster Shared Volumes, ensuring that environments, large and small, that are implemented in less physically secure locations, can have the highest levels of data protection for their key workloads, at no additional cost.

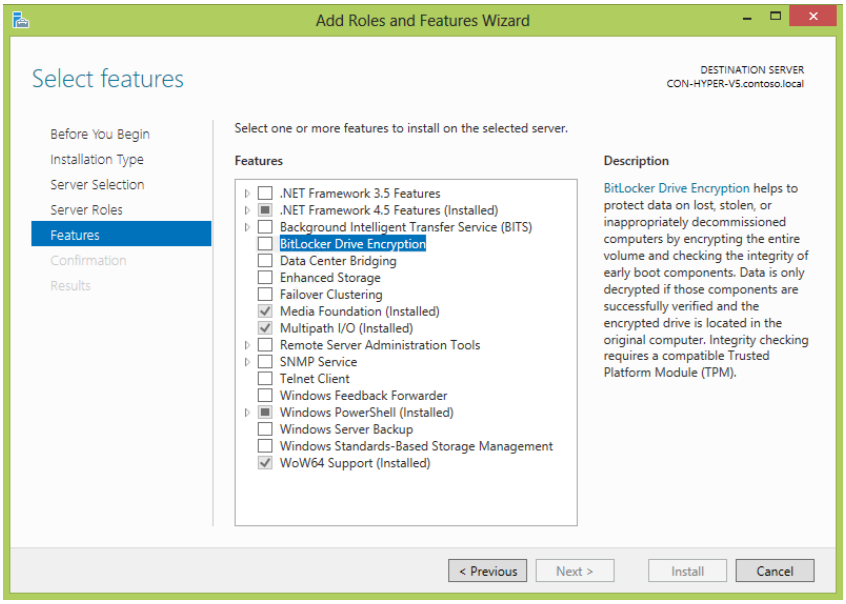

Figure 6 – BitLocker Drive Encryption can be enabled on Microsoft Hyper-V Server 2012 to protect key data

How does VMware compare?

VMware has no capability within the vSphere Hypervisor that can enable the encryption of either VMFS, or the VMDK files themselves, and instead rely on hardware-based or in-guest alternatives, which add cost, management overhead, and additional resource usage.

Flexible Infrastructure

Virtual Machine Mobility

To maintain optimal use of physical resources and to be able to easily add new virtual machines, IT must be able to move virtual machines whenever necessary without disrupting the business. The ability to move virtual machines across Hyper-V hosts is available in Microsoft Hyper-V Server 2008 R2, with a feature known as Live Migration. Microsoft Hyper-V Server 2012 builds on that feature and enhances the ability to migrate virtual machines with support for simultaneous live migrations - the ability to move several virtual machines at the same time, enabling a more agile, responsive infrastructure and a more optimal usage of network bandwidth during the migration process.

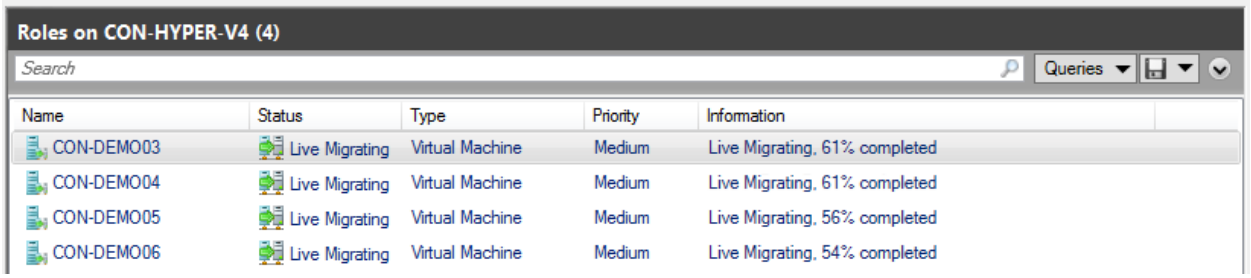

Figure 7 – Virtual machines being migrated simultaneously between hosts

In addition, Microsoft Hyper-V Server 2012 introduces Live Storage Migration, which lets the IT Admin move virtual hard disks that are attached to a running virtual machine. Through this feature, IT can transfer virtual hard disks, with no downtime, to a new location for upgrading or migrating storage, performing backend storage maintenance, or redistributing the storage load. The IT Admin can perform this operation by using a new wizard in Hyper-V Manager or the new Hyper-V cmdlets for Windows PowerShell. Live storage migration is available for both storage area network (SAN)-based and file-based storage.

With Microsoft Hyper-V Server 2012, live migrations are no longer limited to a cluster and virtual machines can be migrated across cluster boundaries. An example of this could be a developer working on a virtualized web server on his local Microsoft Hyper-V Server 2012 host, and once testing is complete, this workload could be migrated, live, with no interruption, from the developer's individual host system, where the virtual machine resides on locally attached storage, across to the production cluster, where the virtual machine will reside on high-performance SAN storage. With Shared-Nothing Live Migration, this migration is seamless, with no interruption or downtime.

Furthermore, when combined with features such as Network Virtualization, virtual machines can even be moved between hosts and clusters that are on different network subnets.

Scale beyond VLANs with Hyper-V Network Virtualization

Isolating virtual machines of different departments or customers can be a challenge on a shared network. When these departments or customers must isolate entire networks of virtual machines, the challenge becomes even greater. Traditionally, VLANs are used to isolate networks, but VLANs are very complex to manage on a large scale. The following are the primary drawbacks of VLANs:

- Cumbersome reconfiguration of production switches is required whenever virtual machines or isolation boundaries must be moved, and the frequent reconfiguration of the physical network to add or modify VLANs increases the risk of an inadvertent outage.

- VLANs have limited scalability because typical switches support no more than 1,000 VLAN IDs (with a maximum of 4,095).
- VLANs cannot span multiple subnets, which limits the number of nodes in a single VLAN and restricts the placement of virtual machines based on physical location.

In addition to the drawbacks of VLANs, virtual machine IP address assignment presents other key issues when organizations move to the cloud:

- Required renumbering of service workloads.
- Policies that are tied to IP addresses.
- Physical locations that determine virtual machine IP addresses.
- Topological dependency of virtual machine deployment and traffic isolation.

The IP address is the fundamental address that is used for layer-3 network communication because most network traffic is TCP/IP. Unfortunately, when IP addresses are moved to the cloud, the addresses must be changed to accommodate the physical and topological restrictions of the data center. Renumbering IP addresses is cumbersome because all associated policies that are based on IP addresses must also be updated.

The physical layout of a data center influences the permissible potential IP addresses for virtual machines that run on a specific server or blade that is connected to a specific rack in the data center. A virtual machine that is provisioned and placed in the data center must adhere to the choices and restrictions regarding its IP address. Therefore, the typical result is that data center administrators assign IP addresses to the virtual machines and force virtual machine owners to adjust all their policies that were based on the original IP address. This renumbering overhead is so high that many enterprises choose to deploy only new services into the cloud and leave legacy applications unchanged.

Hyper-V Network Virtualization solves these problems. With this feature, IT can isolate network traffic from different business units or customers on a shared infrastructure and not be required to use VLANs. Hyper-V Network Virtualization also lets IT move virtual machines as needed within the virtual infrastructure while preserving their virtual network assignments. Finally, IT can even use Hyper-V Network Virtualization to transparently integrate these private networks into a preexisting infrastructure on another site.

How does VMware compare?

Capability	Microsoft Hyper-V Server 2012	VMware vSphere Hypervisor
Virtual Machine Live Migration	**Yes**	No
1GigE Simultaneous Live Migrations	**Unlimited**	N/A
10GigE Simultaneous Live Migrations	**Unlimited**	N/A
Live Storage Migration	**Yes**	No
Shared-Nothing Live Migration	**Yes**	No
Network Virtualization	**Yes**	No

As shown in the table, the flexibility and agility provided by the inbox features of Microsoft Hyper-V Server 2012 are simply unmatched by VMware. The VMware vSphere Hypervisor supports none of the capabilities required for an agile infrastructure today, meaning customers have to purchase a more expensive vSphere 5.1 edition.

With Microsoft Hyper-V Server 2012, Microsoft supports an unlimited number of simultaneous live migrations, within the confines of what the networking hardware will support, with the process utilizing 100% of the available, dedicated live migration network to complete the process as quickly and efficiently as possible, with no interruption to the running virtual machines.

Finally, with Hyper-V Network Virtualization, network traffic from different business units or customers can be isolated, even on a shared infrastructure, without the need to use VLANs. Hyper-V Network Virtualization also lets IT Admins move virtual machines as needed within the virtual infrastructure while preserving their virtual network assignments. IT Admins can even use Hyper-V Network Virtualization to transparently integrate these private networks into a preexisting infrastructure on other sites. With VMware, to obtain any kind of functionality similar to what Network Virtualization can deliver, customers must first purchase the vCloud Networking & Security product, of which VXLAN is a component, and also, as VXLAN requires the vSphere Distributed Switch, customers must upgrade to the Enterprise Plus edition of vSphere 5.1 to take advantage. Network Virtualization has some significant advantages over VXLAN, with one in particular being better integration with existing hardware and software stacks, which is of particular importance when VMs need to communicate out of the vSphere hosts and into the physical network infrastructure. Not all switches are VXLAN aware, meaning this traffic cannot be handled effectively.

Hyper-V Network Virtualization benefits include:

- **Tenant network migration to the cloud with minimum reconfiguration or effect on isolation.** Customers can keep their internal IP addresses while they move workloads onto shared IaaS clouds, minimizing the configuration changes needed for IP addresses, DNS names, security policies, and virtual machine configurations. In the software-defined, policy-based data center networks, network traffic isolation does not depend on VLANs, but is enforced within Hyper-V hosts based on multitenant isolation policy. Network administrators can still use VLANs for traffic management of the physical infrastructure if the topology is primarily static.
- **Tenant virtual machine deployment anywhere in the data center.** Services and workloads can be placed or migrated to any server in the data center while keeping their IP addresses, without being limited to physical IP subnet hierarchy or VLAN configurations.
- **Simplified network and improved server/network resource use.** The rigidity of VLANs and dependency of virtual machine placement on physical network infrastructure result in overprovisioning and underuse. By breaking the dependency, the increased flexibility of virtual machine workload placement can simplify network management and improve server and network resource use. Server workload placement is simplified because migration and placement of workloads are independent of the underlying physical network configurations. Server administrators can focus on managing services and servers, while network administrators can focus on overall network infrastructure and traffic management.
- **No new hardware (servers, switches, appliances) to achieve maximum performance.** Hyper-V Network Virtualization can be deployed in today's data center, and yet is compatible with emerging data center "flat network" technologies, such as Transparent Interconnection of Lots of Links (TRILL, an IETF standard) architecture intended to expand Ethernet topologies.
- **Full management through Windows PowerShell and WMI.** IT can use Windows PowerShell to easily script and automate administrative tasks. Microsoft Hyper-V Server 2012 includes Windows PowerShell cmdlets for network virtualization that let customers and partners build command-line tools or automated scripts for configuring, monitoring, and troubleshooting network isolation policies.

High Availability & Resiliency

Virtualization can promote the high availability of mission-critical workloads in new and effective ways and in Microsoft Hyper-V Server 2012, there are a number of new enhancements that ensure key workloads are resilient, and protected.

- **Incremental Backups -** True differential disk backups of virtual hard disks to help ensure that the data is backed up and restored when necessary. It also reduces storage costs because it backs up only what has changed, not the entire disk.
- **Hyper-V Replica -** Asynchronous, application-consistent virtual machine replication is built in to Microsoft Hyper-V Server 2012. It permits asynchronous replication of Hyper-V virtual machines between two locations for business continuity and failure recovery. Hyper-V Replica works with any server vendor, any network vendor, and any storage vendor.
- **NIC Teaming -** Provides increased reliability and performance for virtual machines.
- **Hyper-V Clustering Enhancements -** By clustering the virtualized platform, customers can increase availability and enable access to server-based applications in time of planned or unplanned downtime. Microsoft Hyper-V Server 2012 provides many new enhancements to the Hyper-V clustered environment.

When it comes to clustering, Microsoft Hyper-V Server 2012 offers unmatched scale and flexibility for virtualized infrastructures:

- **Unmatched Scale** – Microsoft Hyper-V Server 2012 will now support up to 64 physical nodes and up to 8,000 virtual machines in a single cluster providing supreme scalability and flexibility for key virtualized workloads.
- **Flexible Virtual Machine Guest Clustering** – Microsoft Hyper-V Server 2012 provides not only iSCSI guest clustering support, including MPIO, but also enables the use of virtual fibre channel adapters within the virtual machine allowing workloads access to storage area networks using fiber channel fabric. In addition, a virtual fibre channel enables IT to cluster guest operating systems over fibre channel providing HA for workloads within VMs and utilize the built-in Windows multi-path I/O (MPIO) for high-availability and load balancing on the storage path. By employing MPIO and Failover Clustering together as complimentary technologies, users are able to mitigate the risk of a system outage at both the hardware and application levels.
- **Highly Secure Clustered Storage** - Hyper-V, Failover Clustering and BitLocker now work in concert to create the ideal and secure platform for private cloud infrastructure. Microsoft Hyper-V Server 2012 Cluster disks that are encrypted using BitLocker Drive Encryption enable better physical security for deployments outside secure data centers, providing a critical safeguard for the cloud and helping protect against inadvertent data leaks
- **Enhanced Cluster Shared Volumes** - Cluster Shared Volume 2.0 (CSV). CSV has been greatly enhanced in a number of ways. From a usability standpoint, CSV is now a core Failover Clustering feature, with simplified administration and management. To support up to 64 nodes in a cluster, CSV has been improved in aspects of both performance and scalability. In terms of integrating with our partners, CSV has specifically been enhanced to work out of the box with storage filter drivers such as those used by: anti-virus, data protection, backup and storage replication ensuring a more seamless integration with existing investments.
- **3 Levels of Availability** - Microsoft Hyper-V Server 2012 and Failover Clustering work together to bring higher availability to workloads that do not support clustering. It does this by providing a light-weight,

simple solution to monitor applications running in the VMs and integrating with the host. By monitoring services and event logs inside the virtual machine, Hyper-V and Failover Clustering can detect whether the key services that a virtual machine provides are healthy and provide automatic corrective action such as restarting the virtual machine or restarting a service within the VM. This is in addition to the already existing virtual machine failover capabilities should a host fail, or the virtual machine itself become unresponsive.

- **Cluster-Aware Updating** – An in-box end-to-end solution for updating Microsoft Hyper-V Server 2012 Failover Clusters, helping customers to preview, apply, and report on updates, all with zero downtime to the virtual machines.
- **Virtual Machine Failover Prioritization** - Virtual machine priorities can now be configured to control the order in which specific virtual machines failover or start. This ensures higher priority virtual machines are given the resources they need and lower priority virtual machines are given resources as they are available.
- **Anti-Affinity Virtual Machine Rules** - Administrators can also specify that two specific virtual machines cannot coexist on the same node in a failover scenario. VM's can also be kept together (affinity) through the use of preferred host settings.

How does VMware compare?

Capability	Microsoft Hyper-V Server 2012	VMware vSphere Hypervisor
Incremental Backups	**Yes**	No
VM Replication	**Yes**	No
NIC Teaming	**Yes**	Yes
Integrated High Availability	**Yes**	No
Guest OS Application Monitoring	**Yes**	N/A
Cluster-Aware Updating	**Yes**	N/A
Failover Prioritization	**Yes**	N/A
Anti-Affinity Rules	**Yes**	N/A

The table above shows that when it comes to comparing the clustering and high availability capabilities of Microsoft Hyper-V Server 2012 and the vSphere Hypervisor, the restrictions placed on VMware's free edition become quickly evident. Whilst the vSphere Hypervisor does support integrated NIC Teaming for network card resilience, it is lacking any other resiliency features, meaning if customers were to virtualize important workloads on the platform, they would have to upgrade to a more expensive edition in order to provide some form of resiliency and protection for the workloads in question.

Microsoft Hyper-V Server 2012 on the other hand, offers a number of resiliency and high availability features in the box. Integrated Failover Clustering provides the foundation for virtual machine resiliency upon host, and virtual machine failure, and in this release, extends the native protection into the guest operating system, ensuring that if application services start to exhibit problems, corrective action can be taken. VMware offer an API to deliver similar functionality, but it stops there. Customers can purchase 3rd party technologies to provide the specific resiliency capabilities, but these come at additional expense, and an added level of complexity. It's important to note that the use of this API requires that VMware HA, or High

Availability be enabled. Unfortunately, this isn't available in the VMware vSphere Hypervisor meaning key workloads virtualized on these hosts have no resiliency whatsoever.

For customers looking for the highest levels of availability, not only within the datacenter, but between datacenters, Hyper-V Replica, an inbox feature of Microsoft Hyper-V Server 2012, provides a streamlined, efficient and flexible way to asynchronously replicate virtual machines between sites, and in the event of a disaster, start the replicated virtual machines on the alternative site in minutes.

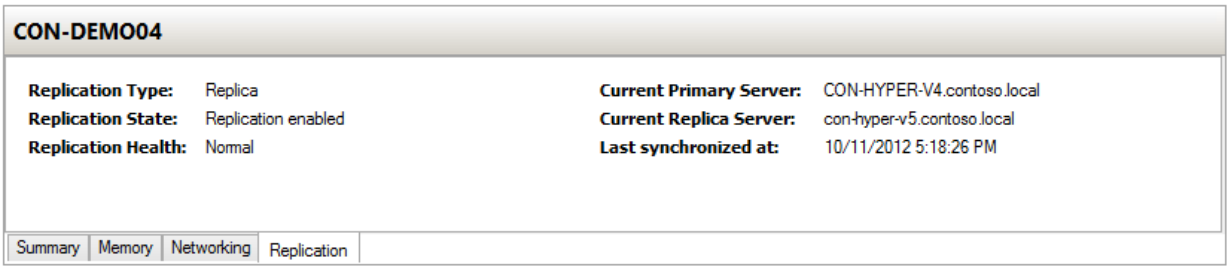

Figure 8 – A virtual machine that is protected by Hyper-V Replica

Hyper-V Replica also provides the ability for customers to not only perform planned and unplanned failovers, but also perform non-disruptive testing on the DR site. Hyper-V Replica also provides a rich, comprehensive PowerShell interface for driving automated scenarios. For customers who already have investments in storage replication technologies through their SAN vendor, the improvements in Hyper-V and Failover Clustering in Microsoft Hyper-V Server 2012, ensure streamlined integration to harness those investments.

When it comes to cluster scalability, both from a physical cluster, and guest cluster perspective, Microsoft Hyper-V Server 2012 leads the way in comparison with VMware:

Capability	Microsoft Hyper-V Server 2012	VMware vSphere Hypervisor
Nodes per Cluster	**64**	N/A
VMs per Cluster	**8,000**	N/A
Maximum Guest Cluster Size (iSCSI)	**64 Nodes**	64
Maximum Guest Cluster Size (Fiber)	**64 Nodes**	5
Maximum Guest Cluster Size (File Based)	**64 Nodes**	0
Guest Clustering with Live Migration	**Yes**	N/A
Guest Clustering with Dynamic Memory	**Yes**	No

As shown in the table, Microsoft Hyper-V Server 2012 offers unprecedented scale, with up to 64 physical cluster nodes, with a maximum of 8,000 running virtual machines on that cluster. This provides large enterprises, and service providers with unprecedented scale to run significant numbers of workloads and achieve a significantly stronger return on investments. The VMware vSphere Hypervisor offers no integrated high availability features, and customers must upgrade to a higher, more costly edition of vSphere to gain those key features.

Customers who wish to construct virtual machine guest clusters, can use the standalone vSphere Hypervisor, however, VMware's support for guest clusters is severely lacking in comparison with Microsoft's flexible offerings. Customers who have invested in iSCSI storage can create guest clusters on the VMware vSphere Hypervisor using the in-guest iSCSI initiator, the same way you would if you were constructing a physical

cluster, thus the supported Guest Cluster size is ultimately determined by the Guest OS itself, which with Windows Server 2012 as a guest OS, 64 nodes would be the largest number. For customers who have invested in file based storage (NFS) with VMware, this is unfortunately unsupported when it comes to creating guest clusters inside virtual machines, and with VMware's virtual fiber channel implementation, presenting a fiber channel LUN directly to virtual machines, the size of the virtualized guest cluster is restricted to just 5 nodes. Compare this with Microsoft Hyper-V Server 2012, which, for a Windows Server 2012 guest cluster, supports up to 64 nodes, over iSCSI, Virtual Fiber Channel, or SMB 3.0, for complete flexibility and unmatched scale.

It's important to note that whilst Microsoft Hyper-V Server 2012 provides a significantly more comprehensive guest clustering capability than VMware in terms of storage integration and support, it also doesn't require customers to sacrifice other features and functionality to work effectively. A virtualized guest cluster on Microsoft Hyper-V Server 2012 supports features such as virtual machine Live Migration, for flexibility and agility, and Dynamic Memory, to ensure the highest levels of density. Compare this with VMware, who, whilst restricting customers to a maximum of only 5 nodes with fiber channel storage, they also restrict customers from migrating the guest cluster nodes using vMotion and additionally, direct customers to disable memory overcommit on those guest cluster nodes, sacrificing density. These are just a few of the limitations with VMware vSphere guest clustering.

Conclusion

In this paper, we have looked at a significant number of the new capabilities that are available within Microsoft Hyper-V Server 2012, across 4 key investment areas:

- Scalability, Performance & Density
- Security and Multitenancy
- Flexible Infrastructure
- High Availability & Resiliency

Across each of these areas, we've detailed how Microsoft Hyper-V Server 2012 offers more scale, a more comprehensive array of customer-driven features and capabilities, and a greater level of extensibility and flexibility than the standalone VMware vSphere Hypervisor. With features such as Hyper-V Replica, cluster sizes of up to 64 nodes and 8,000 virtual machines, Storage and Shared-Nothing Live Migration, the Hyper-V Extensible Switch, Network Virtualization, and powerful guest clustering capabilities, it's clear to see that Microsoft Hyper-V Server 2012 offers the most cost-effective, comprehensive virtualization platform for the next generation of cloud-optimized infrastructures.