White Paper

Cisco Unified Computing System and Microsoft Windows Server 2012: Get the Most Complete Solution

What You Will Learn

Microsoft Windows Server 2012 is a huge step in Microsoft's evolution and provides an industry-leading platform for virtualization that can provide the foundation both for on-premise private clouds and for host-provided public clouds. The main new features of Microsoft Windows Server 2012 include:

- Virtualization for a heterogeneous environment with industry-leading capabilities for Microsoft Windows and Linux workloads
- Enhanced manageability, supporting large-scale server management with the same simplicity as single-server management
- Capability to run any application in any cloud using a common feature set for both on and off-premises deployments

The Cisco Unified Computing System™ (Cisco UCS®) server family makes full use of these enhancements and adds capabilities based on Cisco's experience and innovations as the industry's leading network and datacenter technology provider to deliver a complete solution for your enterprise based on Microsoft Windows Server 2012 with Hyper-V. The main Cisco® complementary technologies discussed in this document include the following:

- Cisco UCS server platform
- Cisco Nexus® 1000V Series Switches and Cisco Data Center Virtual Machine Fabric Extender (VM-FEX)
- Cisco UCS Manager and other Cisco management technologies

Virtualization Technology

The use of virtualization for server deployments and even desktop services through virtual desktop infrastructure (VDI) and session virtualization has become standard for most organizations with a "virtual first, physical by exception" focus. With the emphasis on virtualization, the virtual platform must offer the virtual environment a complete solution, allowing the services and applications on the virtual machines to access the full capabilities and scalability of the underlying computing resources without compromise. Microsoft Windows Server 2012 delivers an operating system and virtualization platform that provides industry-leading performance and feature sets.

Scalability and Performance

Virtualization is no longer seen as a technology for tier-2 and tier-3 applications only. Organizations now strive to virtualize all applications in the data center, including tier-1 applications, which traditionally may require very large numbers of processors and network resources and very large amounts of memory and disk space. Microsoft Windows Server 2012 provides support for the largest x86-based servers, including servers with 320 processor

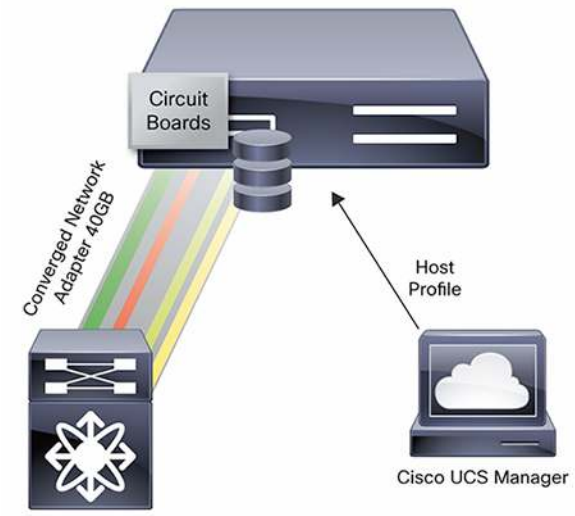
cores and 4 terabytes (TB) of memory. The support for very large environments is also reflected in the following new capabilities for virtual machine configurations:

- 64 virtual CPUs (vCPUs) per virtual machine
- Full support for nonuniform memory access (NUMA), with NUMA topology exposed to virtual machines, allowing NUMA-aware applications in a virtual machine to run fully optimized based on knowledge of the physical processor and memory topology
- 1 TB of memory per virtual machine
- New 64-TB extended virtual hard disk (VHDX) format, which removes the prior 2-TB VHD limit and the need to use pass-through storage for scenarios in which very large volumes are required
- Failover clusters with 64 nodes and support for 4000 virtual machines per cluster

The new scalability metrics for virtual machines provide the capability for almost any workload to be virtualized on Microsoft Windows Server 2012 Hyper-V. As shown in Figure 1, the Cisco UCS server platform does provide a blade-based solution (in addition to its chassis-based offerings) that offers the latest x86-based server environment, which can push Microsoft Hyper-V to its full scalability limits, and also features converged network adapter (CNA) that connects to a unified fabric, which in turn provides a single 40-GB network connection for each blade. This single connection can be divided into up to 256 virtual adapters using the Cisco UCS management framework, and each virtual adapter is seen by the operating system running on the Cisco UCS blade as either a physical network or Fibre Channel host bus adapter (HBA) device.

The capability to create this number of network and HBA devices separates the Cisco UCS platform from other blade-based solutions, which typically are very limited in terms of adapter connections because of the limited number of physical slots. Many Microsoft best practices require numerous separate network and storage connections, especially when using virtualization. The CNA helps ensure that your platform investment meets today's Microsoft best practices as well as guidelines for tomorrow's best practices. In the example in Figure 1, three network adapters with varying bandwidths and a Fibre Channel HBA have been created through a host profile applied using Cisco UCS Manager.

Figure 1. Cisco UCS Server Platform Includes a CNA That Connects to a Unified Fabric



The flexibility of the CNA is not at the expense of performance, with a recent demonstration at TechEd 2012 Europe showing the Cisco UCS platform providing 900,000 I/O operations per second (IOPS) of throughput, which also supports virtualization of even the most demanding workloads and helps ensure that Cisco UCS can meet the demands of future workloads.

The Cisco UCS platform, while storage independent, supports the latest storage technologies and can expose the new Microsoft Windows 2012 storage improvements both for client access to storage using the Server Message Block (SMB) 3.0 protocol and direct access to the SAN from the Cisco UCS platform. Microsoft Windows Server 2012 introduces a major new version of the SMB protocol, which enables SMB to be used as a storage protocol for tier-1 applications such as Microsoft SQL Server and Hyper-V in addition to its more traditional use for data access: for example, for Microsoft Office documents. Small Computer System Interface over IP (iSCSI) is also a core file service in Microsoft Windows Server 2012. Performance of data duplication and movement on a SAN is exponentially improved with Microsoft Windows Server 2012 with the new Offloaded Data Transfer (ODX) capability, which will be supported by many major SAN vendors. ODX changes the way that Microsoft Windows Server 2012 interacts with SAN-based storage. Traditionally with data actions on a SAN, the Microsoft Windows operating system reads the data from the SAN into the host memory and then writes the data to the SAN, which causes delays. ODX allows Microsoft Windows Server 2012 to be removed from the data duplication and move processes, instead providing the SAN instructions about the data manipulations required, which are then performed directly internally in the SAN, reducing operations from minutes to seconds.

Features

Large-scale scalability is critical to the virtualization of all applications; however, more than just large numbers of processors and large amounts of memory are required for a complete solution for virtualized workloads. Microsoft Windows Server 2012 in combination with the Cisco UCS server family provides a feature set that offers both exceptional capabilities and outstanding manageability, as discussed later in this document.

Fibre Channel Support

One adapter type supported by the previously mentioned unified fabric and CNA is the Fibre Channel HBA, which provides communication to storage. This adapter is vital for the Cisco UCS blades for storage of the Cisco UCS boot environment and for storage for data and virtual machines, but Microsoft Windows 2012 provides a new possibility for Fibre Channel access storage. Before Microsoft Windows Server 2012, the only way for guest operating systems to access a SAN was through the IP-based iSCSI protocol, which could operate on a standard network connection. This approach meant that, for guest-level clustering, any shared storage had to be accessed through iSCSI, which limited access to many SANs and prohibited the use of many SAN management tools within the guest system. Microsoft Windows Server 2012 Hyper-V supports virtual Fibre Channel, allowing virtual machines to have direct access to Fibre Channel–connected SANs and removing previous limitations for virtual machine access to SANs.

Live Migration

The Cisco UCS platform allows hundreds of blades to be managed as a single unit, but even with the new Microsoft Windows Server 2012 scalability improvement of 64-node clusters, organization still may have a greater number of blade servers than can be placed in a single Microsoft Windows 2012 cluster. The use of multiple clusters would traditionally limit the capability to move virtual machines between physical hosts without any downtime for the guest operating system using the Microsoft Hyper-V live migration technology, which was cluster

bound. Microsoft Windows Server 2012 introduces the capability to run virtual machines on SMB file shares, which means that there is no need for cluster shared storage.

Microsoft Windows Server 2012 also supports a new type of virtual live migration (also known as “shared nothing” live migration), which allows a virtual machine to be moved between any two Microsoft Windows Server 2012 Hyper-V hosts with no need for common storage or configuration and no downtime for the virtual machine. The virtual machine storage, memory, and device state are all copied and synchronized while the virtual machine continues to run, and then the virtual machine is switched to the new host, remaining online and available to clients without interruption. Shared-nothing live migration can be used between stand-alone hosts, between clusters of hosts, and between clustered and nonclustered hosts; this approach provides complete mobility for the virtual machines and flexibility for the organization. The Cisco UCS server family’s unique unified fabric provides a connectivity that virtual and traditional live migration can fully use, providing fast migration across the data center. It also supports multiple concurrent migrations, which dynamically adjusts the maximum number of concurrent live migrations based on available bandwidth, helping ensure the best experience. Virtual machine storage can also be moved while the virtual machine continues to run, using the new Microsoft Hyper-V Storage Move feature, providing the capability to move between any supported storage such as direct attached, SAN, and SMB with no interruption to the running of the virtual machine.

Networking

With virtualization now standard in the data center, all aspects of the infrastructure must be evaluated and the implementation verified to help ensure that it offers the best capabilities possible. One of the most important aspects of the data center that has largely been neglected during the virtualization evolution and adoption is the network infrastructure, also known as the network fabric. Virtualization has virtualized and abstracted the computing resources such as CPU and memory in addition to virtualizing storage through virtual hard disks. The network used in virtual environments has not benefited from virtualization and has been tied to the topology of the physical network fabric, with virtual environments being tied to the configuration of the underlying network and with management of the virtual network switches performed in tools specific to Microsoft Hyper-V. This tight coupling between virtual machine networks and the physical network fabric introduces many complexities when an enterprise is trying to host multiple organizations on a single infrastructure, with some organizations potentially wanting overlapping IP configurations or requiring complete segregation, and it also is problematic if the capability to move virtual machines between data centers and potentially to the public cloud without requiring changes in the virtual machine network configuration is required.

Network Virtualization

Microsoft Windows Server 2012 and Cisco technologies bring network capabilities to organizations where they need them today. Microsoft Windows Server 2012 introduces network virtualization, which allows virtual networks to be defined that are completely abstracted from the underlying physical network fabric. An organization could create, for example, a red network and a blue network that, while physically traveling on the same physical network fabric, uses overlapping IP configurations and spans multiple physical locations, including a mix of on-premises and off-premises servers. Each virtual network is invisible to other virtual networks, providing completely segregated network communication for different tenants of an infrastructure. Network virtualization can be enabled through a software IP address rewrite mechanism that converts the IP address used on the virtual network to one routable on the physical network, which is then converted back after the traffic reaches the Microsoft Hyper-V host that is hosting the target virtual machine. A hardware-supported method is also used through Generic Routing

Encapsulation (GRE), which is fully supported by Cisco UCS and provides the best Microsoft Hyper-V network virtualization performance and experience; however, users of Cisco solutions have additional choices.

Most data centers consist of three layers of network hardware, which are managed by the network operators:

- The access switch providing connectivity for all the hosts in a rack
- The aggregation switch that connects multiple access switches
- The core switch that connects the aggregation switches and provides the network backbone connectivity

Network operators have experience in the management of these three layers of network hardware and use a consistent management methodology. The introduction of virtualization into a data center also introduces three problems for network operators:

- Virtualization allows movement of virtual machines between hosts. After network policies such as security and balancing are defined, it is important to help ensure that policy is maintained and applied no matter where the virtual machine moves.
- Network operators have no visibility into virtual traffic, which often never reaches the physical switch and is routed internally in the virtual switch. This lack of visibility makes it difficult to troubleshoot networking problems between virtual machines.
- Typical virtualization management tools put too much pressure on the virtualization administrator and force the administrator to learn and define network policies, security policies, and load-balancing polices that normally are managed by network and security administrators.

Extensibility for Microsoft Hyper-V Network Switch

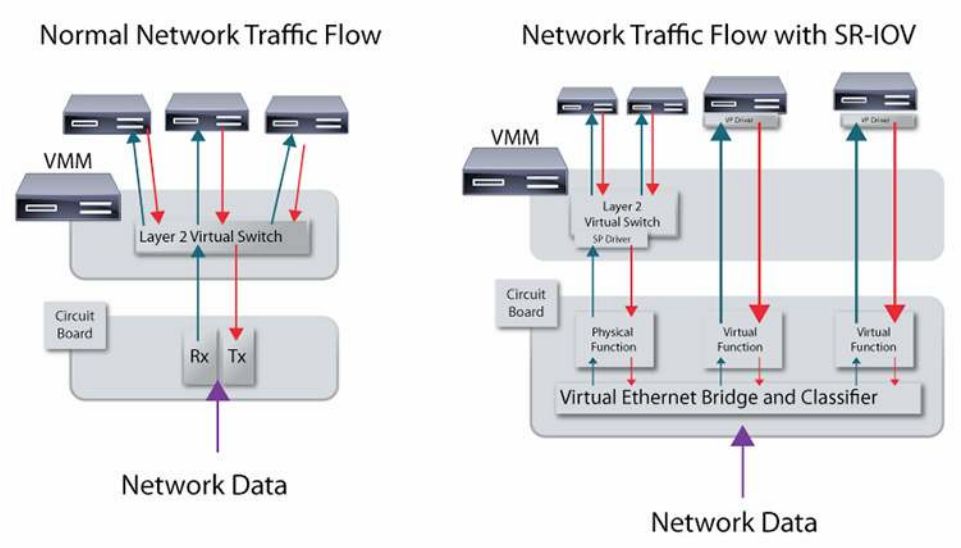
Microsoft Windows Server 2012 Hyper-V introduces extensibility to the Microsoft Hyper-V network switch, allowing third parties to plug into the Microsoft Hyper-V network switch to extend capabilities using existing Microsoft Windows mechanisms with which partners are already familiar, such as the Microsoft Windows Filtering Platform (WFP) for firewall and intrusion solutions and the Network Driver Interface Specification (NDIS) filter for network packet inspection, filtering, and forwarding. Cisco has used the new Microsoft Hyper-V switch extensibility capability to enable the industry-leading Cisco Nexus 1000V Series to integrate with Microsoft Hyper-V virtual switches. The Cisco Nexus 1000V Series provides the full management of the new virtual access layer that virtualization introduces, solving the three challenges introduced virtualization. Using the Cisco Nexus 1000V Series brings the management and experience of the network for the Microsoft Hyper-V virtual machines back to the network operators in a consistent manner with integration with the physical network infrastructure through the Cisco UCS management tools. The Cisco Nexus 1000V Series provides network virtualization capabilities in addition to advanced network policies, giving customers excellent flexibility and choice.

- Direct Memory Access (DMA), which allows very fast network data transfer directly between hosts without major load on the host processor
- Data Center Bridging (DCB), which provides support for hardware-level network services, such as quality of service (QoS) operations

However, Cisco UCS Data Center VM-FEX provides customers with the highest level of network performance, matching bare-metal network throughput for the most demanding workloads.

Cisco Data Center VM-FEX extends the unified fabric technology and the CNAs to provide support for another new Microsoft Windows Server 2012 Hyper-V capability: Single Root I/O Virtualization (SR-IOV). Traditionally, virtual switches are created in Microsoft Hyper-V, and these are connected to a physical network adapter and provide external connectivity to the virtual machines connected to the virtual switch. The virtual switch provides many services to the virtual machines and supports extensibility by third parties. The switching does introduce some latency to communications because network traffic is processed through the virtual switch. SR-IOV allows virtual machines to directly communicate with virtual devices, using virtual functions, which are provided by the network adapter, directly bypassing the virtual switch and providing bare-metal performance. SR-IOV-capable network adapters support a certain number of virtual functions, and each virtual function can be attached to a single virtual machine virtual network adapter at any one time. Cisco Data Center VM-FEX provides support for SR-IOV and, in combination with unified fabric, provides the highest levels of performance while still allowing management and monitoring through the standard Cisco UCS management framework. Cisco Data Center VM-FEX essentially extends the switch interface directly to a virtual machine (Figure 2).

Figure 2. Network traffic Comparison with SR-IOV



Bare-Metal Performance Without Sacrificing Mobility

The use of any technology that directly connects a virtual machine to a physical piece of hardware is normally considered a bad idea, because virtualization should abstract and break bonds between the virtual environment and the physical fabric. Typically, a virtual machine that is bonded to a physical element hinders the ability to move a virtual machine without downtime using Microsoft live migration; however, this is not the case with SR-IOV and Microsoft Windows Server 2012 Hyper-V. Invisible to both the virtual machine guest operating system and the administrator, the Microsoft Hyper-V network logic actually creates a connection for a virtual machine configured with SR-IOV using SR-IOV, and it creates a connection to a synthetic network adapter through the traditional network switch. Under normal circumstances, the SR-IOV connection is used; however, if Microsoft live migration is initiated, then the network connection switches to the synthetic network adapter using the virtual switch and the live migration is performed, and then after the virtual machine is running on the target Microsoft Hyper-V host, a check is performed, assuming that SR-IOV is available and assuming that the available the network connection switched to an SR-IOV connection. This process allows organizations to benefit from the Cisco Data Center VM-FEX bare-metal performance and common manageability without sacrificing mobility of the virtual environment.

For organizations that use the teaming of multiple network adapters, Microsoft Windows Server 2012 offers a native network interface card (NIC) teaming capability, allowing up to 32 network adapters to be used in a single team. This feature allows customers to choose whether to use native NIC teaming provided in the network adapter driver, which may offer more advanced features, or to use the teaming solution supported by Microsoft.

The Cisco UCS server family, when combined with the Cisco Nexus 1000V Series or Cisco Data Center VM-FEX, provides an exceptional network management capability that allows organizations to maintain the operational processes currently used, reducing the risk of technology adoption.

Manageability

Microsoft Windows Server 2012 is built on the management philosophy “the power of many, the simplicity of one”—that is, that managing multiple servers should be as easy as managing only one. In support of this philosophy, the Microsoft Windows Server 2012 Server Manager has been redesigned to support management of multiple servers simultaneously and to allow the creation of custom groups of servers, with a high-level dashboard showing the overall health of the managed servers. Although the new server manager capability is very powerful, for true data center automation actions that can be scripted are necessary, and Microsoft has substantially boosted the capability of Microsoft Windows PowerShell, providing more than 2300 intuitive cmdlets, allowing the management of almost every aspect of Microsoft Windows Server 2012. Cisco builds on the Microsoft Windows PowerShell with Cisco UCS PowerTool, which extends the Microsoft Windows PowerShell capability with a Cisco library that provides Cisco UCS management through the common Microsoft Windows PowerShell interface and enables administrators familiar with the Microsoft product to quickly integrate with Cisco UCS and to use a single management platform to access all aspects of the virtual infrastructure.

Cisco and Microsoft Management Tools

Beyond the native Microsoft Windows Server 2012 management tools, Microsoft System Center 2012 is the Microsoft flagship management and monitoring solution for all aspects of an organization’s Microsoft environment, including the desktop, the servers, the physical infrastructure, the virtual infrastructure, the hardware—all the way through to the application. Microsoft System Center 2012 builds on nearly 20 years of Microsoft management tool experience. Cisco UCS Manager is the Cisco management tool that provides end-to-end management of the Cisco UCS platform, and in addition to the Microsoft Windows PowerShell library for Cisco UCS, Cisco provides Cisco UCS Manager integration with two main components of Microsoft System Center 2012: Operations Manager

and Orchestrator. The Cisco UCS Management Pack for Microsoft System Center 2012 Operations Manager allows the monitoring and health insight of Cisco UCS components. Microsoft System Center 2012 Orchestrator acts as an IT automation toolbox, providing connectivity to the many different IT systems in the data center, and then a series of actions can be defined in run books, which can be used either manually or by other systems, removing the need for manual processes, which previously may have involved accessing many different tools. The Cisco UCS Integration Pack for Microsoft System Center 2012 Orchestrator allows Orchestrator to connect and perform actions on Cisco UCS Manager as part of multisystem workflows, extending the capabilities of automated actions.

In addition to providing the basic management of the Cisco UCS server family, such as the configuration of the unified fabric, Cisco UCS Manager provides capabilities that are vital to multiserver environments, in which, even with the best hardware, failures still occur. Service templates enable templates to be defined, which, at a very detailed level, list the configuration for a deployed blade server, such as the number of network adapters, number of Fibre Channel connections, and other hardware configuration options. The service template can then be used to quickly provision new blades to a desired configuration. Further, in the event of a blade failure, a replacement blade can be identified, and through the service template, the hardware configuration of the failed blade can be applied to the replacement blade, including the operating system on the shared storage from which to boot, essentially allowing the failed blade to be replaced in minutes.

Cisco UCS Manager won the Microsoft Tech Ed 2012 Breakthrough Technology Award, and the integration of Cisco UCS Manager with Microsoft System Center 2012 provides organizations with a single pane through which full visibility and management of the physical and virtual infrastructure is possible.

Conclusion

Microsoft Windows Server 2012 offers greatly tremendous server virtualization capabilities and a cloud platform, with enhancements in the Microsoft Windows Server 2012 operating system and many enhancements in the Microsoft Hyper-V feature. The Cisco UCS platform in combination with the Cisco Nexus 1000V Series and Cisco Data Center VM-FEX provides the most complete platform for Microsoft Windows Server 2012 Hyper-V, enabling organizations to take full advantage of the Microsoft Windows Server 2012 Hyper-V capabilities and also to extend them through Cisco innovations. Further, the Microsoft Windows PowerShell and integration between Cisco UCS Manager and Microsoft System Center 2012 help enable organizations to use a single, unified approach for managing all aspects of the Microsoft and Cisco solution. With all these features, Microsoft Windows Server 2012 and Cisco UCS provide the best and most complete solution on the market.

For More Information

For more information, contact your Cisco or Microsoft representative, or visit www.cisco.com/go/microsoft.

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