White Paper

Intel® Xeon® processor and Windows Server* 2008 Hyper-V*

Server Consolidation with Intel® Xeon® Processors and Windows Server* 2008 Hyper-V*

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Introduction

In today's highly competitive market place, companies are placing more and more pressure on their IT departments to deliver increased value at every key performance indicator that can be measured. These performance indicators include server utilization, power consumption, rack density, availability, and cost of deployment and maintenance. Delivering this increased value requires innovative new solutions from IT departments. Server consolidation, made possible by virtualization technology, is such a solution, and it has quickly taken its place as a critical part of many corporate datacenters. Server consolidation focuses on maximizing the usage of a physical server, improving key performance indicators while reducing costs.

Intel® Xeon® processors, when combined with Microsoft Windows Server* 2008 Hyper-V,* provide a strong set of benefits that enable server consolidation through virtualization. While Hyper-V provides a solid software platform upon which to run multiple virtual machines, the scalable performance of the Intel Xeon processor boosts the effectiveness and energy efficiency of host servers, increasing consolidation ratios while maximizing virtual machine performance and minimizing power consumption. This allows IT departments to deliver more value to the enterprise, while managing the increased demand for resources.

As virtualization gains acceptance as a highly effective means to consolidate servers, Intel Xeon processors have been engineered with new features that result in more efficient use of hardware, while at the same time maintaining the level of performance that is required by a given application. This white paper will provide insight into these new features of the Intel Xeon processor, and how Hyper-V leverages them. In addition, this white paper will provide details about high-level decision points that IT departments should consider when implementing a server consolidation strategy, so as to maximize their investment in Intel and Microsoft technology.

Features of the Intel® Xeon® Processor: How They Benefit Server Consolidating Using Windows Server* 2008 Hyper-V*

The immediate benefit of consolidating servers is a reduction in the number of physical servers that need to be managed. Moreover, there is an array of less obvious benefits that can lead to considerable gains across all areas of IT. To realize these benefits, an organization needs to have a solid platform upon which to consolidate servers. Windows Server 2008 Hyper-V is the virtualization technology from Microsoft that provides the software component of such a platform, allowing multiple virtual machines to run on a single host server. When combined with the features found in Intel Xeon processors, Hyper-V can draw additional benefits for server consolidation scenarios.

Energy efficiency

Intel continues to innovate in the area of efficient power usage in processors. Perhaps the most critical area of innovation from Intel in this area is the industry's first 45nm fabrication process, which increases performance as much as 14 percent yet reduces power usage as much as 44 percent over similar processors based on 65nm technology.[1] Built using a combination of new materials, including hafnium-based high-k gate dialectrics and metal gates, Intel® 45nm technology is a revolutionary advancement in processor fabrication. With double the number of transistors in the same footprint and a 20 percent improvement in transistor switching, this process delivers dramatically improved performance, while the 10-fold reduction in transistor gate leakage drives energy consumption down to levels not seen before. All of this means more performance in less space with less power.

Intel has also improved energy efficiency by improving on processor features to allow for better control of the processor environment. Demand Based Switching is one such feature, which minimizes wasted energy by dynamically changing processor performance or power states based on utilization. Demand Based Switching allows the processor to dynamically select optimal P-states and T-states, providing the opportunity for a more effective power budgeting in the data center.

Virtual machine performance

Hyper-V has been designed to take advantage of a new suite of hardware-assisted virtualization features from Intel: Intel® Virtualization Technology (Intel® VT).[2] Intel VT features can be found across the hardware stack – in Intel Xeon processors, Intel® chipsets, and Intel® communication components – and combine to reduce latency, accelerate performance, and improve utilization by freeing the processor from overhead tasks.

Intel VT is specifically implemented inside the Intel Xeon processor by way of a set of processor extensions. One of these is Intel® VT FlexPriority, which was designed to accelerate virtualization interrupt handling, thereby decreasing processor overhead and improving virtual machine performance. Intel VT FlexPriority can help provide incremental performance improvement and faster boot times for virtual machines. Industry-leading features like Intel VT FlexPriority help virtual machines achieve near-native performance levels on Intel Xeon processor-based servers.

Collectively, Intel VT helps Intel Xeon processor-based servers provide a server platform optimized for virtualization, delivering near-native performance of virtual machines. Hyper-V has been optimized to take advantage of Intel VT, and so together they allow organizations to maximize the value of their hardware investment.

Reliability

Intel Xeon processors are architected from the ground up to provide reliable performance for virtual machines. With redundancy built into Intel components to provide enhanced performance and reliability, Intel Xeon processors provide a rock-solid platform for running high virtual machine loads. The reliability features include:

- Fully buffered DIMM technology: Helps enable a more robust memory system, preventing memory errors from causing system disruption.
- Memory Error Correcting Code (ECC): Helps avoid memory errors.
- System bus enhancements: Helps to provide for more reliable data flow into and out of memory.
- Memory mirroring: Helps protect data that is loaded into RAM.
- Hot-Add Memory support: Allows ranges of memory to be added without rebooting or downtime.
- I/O hot-plug support: Enhances system reliability and helps to prevent downtime due to I/O failure.
- Support for Windows Hardware Error Architecture (WHEA): WHEA provides a common infrastructure for handling hardware errors on Windows platforms. WHEA is intended to reduce mean-time-to-recovery for fatal hardware errors through richer error reporting and to reduce system crashes related to hardware errors through effective operating system hardware error recovery and health monitoring.

Choosing an Intel Xeon Processor for Your Server Consolidation Project

The breakthrough performance, energy efficiency, and reliability of Intel Xeon processor-based server systems make them the ideal choice for virtualization and consolidation projects or high-density deployments in power-constrained data centers.

7000 sequence[Δ]: The Intel Xeon processor 7000 sequence, based on the Intel® Core™ microarchitecture, offers leading scalable performance and best-in-class virtualization for server consolidation.

5000 sequence[Δ]: The breakthrough performance, energy efficiency, and reliability of Intel Xeon processor-based server systems make them the ideal choice for all of your data-demanding or standard enterprise infrastructure applications.

Server Consolidation Best Practices

When planning to consolidate servers using Windows Server 2008 Hyper-V, there are a series of best practices that should be examined. Some practices may not apply to your specific situation; however, it is important to take each one into consideration before moving physical server workloads to virtual environments.

The most important reason to follow best practices is to ensure a minimal amount of services downtime during migration. Then, once the workload has been migrated, the challenge is to ensure that services provided to end users are not negatively affected.

Planning for server consolidation

In most organizations, server consolidation will require careful planning and a strong communication plan for all parties who can be affected by the server consolidation. End users must be aware that there may be downtimes during the transition period. Application development groups must be aware of how the transition to virtual technology will impact their applications. IT administration groups must be fully trained on how to handle issues in virtual environments. Each group that is affected needs to test and update their own documentation. Finally, consolidating physical servers into virtual servers will rarely be a turnkey solution, meaning that the technology to quickly virtualize a workload will be given. However, getting sign off from the stake holders will make planning and testing an extremely important aspect of virtualizing applications for server consolidation projects. The following sections detail several high-level steps that should be part of any consolidation plan.

Determine which servers are suitable for virtualization

The first step to accomplish when creating a server consolidation plan is to determine which server workloads are suitable for virtualization. In this step you need to evaluate current workloads to get a detailed understanding of how the physical server is being utilized. This should include a historical understanding of how the server is used. If the server utilization peaks during a certain period of time, for instance during month ends, then it may require additional resources or considerations when choosing to move the workload to a virtual server.

It is also important to consider specific application requirements. Applications that have special hardware requirements such as a hardware device for copy protection may require additional steps to successfully virtualize. You should consult with your application vendors to ensure that they will support application running on a virtual environment.

The final decision when deciding to move a physical server workload will come down to evaluating whether or not it is possible to move the workload to a virtual environment, and what the associated risks with moving the workload to a virtual environment are.

Once you have created the list of applications that will be transitioned into a virtual environment, you should prioritize each application based on when the best time to virtualize the application would be, how critical the application is to business operations, and what kind of remediation will be necessary to migrate the application.

Determine the resources required to power the virtual environments

Once you know what workloads will be virtualized, planning the resources needed to run the workloads will be required. Each workload that will be virtualized will first need to be considered individually, and then in context of other application workloads.

When considering workloads individually, resources should be planned to meet the peak requirements of a given application workload. Benchmarking the workload to determine the peak level of usage is important. It is also important to gain an understanding of how a workload will grow, and ensure that the virtual environment configured for the workload will be able to scale with the workload growth.

Next, consider the requirements of the workload in context of other workloads to decide how virtual machines will be placed on the host servers. You may decide to place several servers together that require little processing time. For example, DHCP servers often require limited CPU, and have periodic maintenance tasks than can be scheduled. Therefore, there are good candidates to consolidate along with other servers. Caution should be used however, as consolidating servers that provides the same service in redundancy should be avoided. Using the DHCP server as an example, most environments run multiple DHCP servers to provide IP address information in the event that one server fails. If a host server fails running both DHCP servers, then the purpose of running a multiple DHCP servers is defeated.

The next consideration to make in terms of resource allocation is what kind of physical requirements the workloads will have.

- Hyper-V leverages multi-core Intel Xeon processors, allowing workloads to be dynamically distributed over one to four cores. In general, the more cores available, the more virtual machines that can be hosted on the server.
- The fastest memory and Front Side Bus combinations possible should be used. There should be enough memory for each virtual machine, as well as enough memory to accommodate the parent partition. This may be less if the parent partition is running server core. Memory should also be Error Checking and Correcting (ECC), ensuring enhanced reliability and protection from memory failure.

The final consideration around resource allocation is to determine any additional I/O needs. As the number of virtual machines on a server increases, bandwidth needs also increase. Additional network adapters can meet these needs and should also be considered for technologies such as ISCSI if they are being leveraged in the environment.

- Dual-port and quad-port Intel® Gigabit Server Adapters provide redundancy in the event of a switch port failure. Combined with Microsoft Multipath I/O and Fail-Over Cluster services, virtual machine hosts can be made to be highly reliable. When implementing iSCSI, every iSCSI connection should have its own network interface, separate from normal network traffic.
- Network adapters can be dedicated to a single virtual machine. This provides the virtual machine with a very fast connection potential to an ISCSI data source that can be configured using Microsoft's native iSCSI initiator. This provides a performance boost for virtual machine with hard disk-intensive operations.

There are currently several limitations for Hyper-V in regards to interfacing with USB devices and host bus adapters. As such, it is important to validate that application workloads will able to function within the hardware constraints of the virtual environments.

Determine backup, disaster recovery and high availability requirements

As businesses increase their dependency on IT teams for providing reliable services, planning high availability becomes an essential part of any consolidation plan. It is important to determine in advance what kind of Service Level Agreements (SLA) are in place or should be defined for each virtualized workload. The SLA will dictate the backup plan, disaster recovery requirements, and what kind of tolerance the business has to loss of the service.

In planning for availability, it is important to consider fault-tolerance requirements for the physical server as well as the virtual server.

Hyper-V offers several features to help with all aspects of achieving high availability. This includes support for child partition clustering using failover clustering, which allows for a child virtual machine to fail over from one physical server to another in the event a physical server experiences a failure. Hyper-V also supports volume shadow copies that allow virtual machines to be backed up while they are running. Finally, Hyper-V supports snapshots, so that changes can be made to a VM with an instant rollback strategy in place in the event that the changes cause a problem with the virtual machine.

All of these features can be used to create a comprehensive plan to ensure Virtual Machines are always available.

Determine security requirements

By consolidating many servers to a single physical server, security of the physical server and the virtual servers becomes much more important. In general, a security breach on the parent operating system can cause havoc on a network, since all the workloads running on the physical server can be simultaneously brought down, or used in a malicious manner.

When planning to deploy virtual machines, several steps can be taken to minimize the potential for attack:

- Use a Server Core installation of Windows Server 2008 as the parent partition in order to reduce the attack surface.
- Deploy the physical server with two physical network cards:
  - One for management of the physical server
  - One dedicated to VM networking
- Secure Virtual Machines Configuration files (VMC) using ACLs.
- Secure Virtual Machine Hard Disk Files (VHD) using ACLs.
- Keep virtual machines patched (even offline virtual machine should be regularly patched. This can be accomplished with advanced tools from Microsoft).
- Use VLANs to segment virtual machines into their own virtual segments. Possible configurations include:
  - Local Access only
  - NAT
  - IPSec isolation
- Run AV software on parent and child partitions:
  - On the parent partition, exclude VHD folders
  - On child partitions, run normal settings for AV client

Conclusion

Server consolidation with Intel Xeon processors and Windows Server 2008 Hyper-V can dramatically improve server density, and allow businesses to provide drastically more services using the same power, cooling, and data center facilities. These gains will allow IT departments and teams across the organization to focus on delivering robust solutions while minimizing the time to deployment and maximizing the investment in IT infrastructure.

[1] Source: http://communities.intel.com/docs/DOC-1243

[2] Intel® Virtualization Technology requires a computer system with an enabled Intel® processor, BIOS, virtual machine monitor (VMM) and, for some uses, certain platform software enabled for it. Functionality, performance or other benefits will vary depending on hardware and software configurations and may require a BIOS update. Software applications may not be compatible with all operating systems. Please check with your application vendor.

[Δ] Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See www.intel.com/products/processor_number for details.

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