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DELL

How the Right Infrastructure Delivers Real SQL Database Virtualization Benefits

The amount of digital data stored worldwide stood at 487 gigabytes as of May 2009, and data volumes are doubling every 18 months[1]. Demand to probe that data for information and insight is burgeoning, too.

The era of database server business-as-usual has ended …

You're not alone if you're feeling pressure to get your database servers to support complex real-time analysis and handle vast numbers of user requests.

Where does it hurt?

Check all that apply to you:

- ☐ I'm running out of room in my data center
- ☐ My servers are *way* under-utilized
- ☐ My data center power bills are outrageous
- ☐ Managing our applications and servers is a nightmare
- ☐ I've got too many databases that can't work together and/or are struggling to meet users' needs

Fortunately, increased demand can be met through virtualization and consolidation techniques made more effective than ever by a new-generation architecture for x86-based servers — AMD's Opteron™ 6000 Series platform, which has broken through the traditional '4P tax' barrier to deliver a 4-processor (4P) performance at 2P economics[2].

Value 4P: Scalable 4P performance at 2P prices

For database applications and other solutions that must balance performance and scalability, the processor, memory, and I/O capabilities of 4P platforms generally do a better job than 2P alternatives — but the advantages of 4P platforms have traditionally not outweighed the higher 4P pricetag.

Now all that has changed. AMD's Opteron™ 6000 Series Platform has eliminated the '4P tax' by offering a common price structure for 2P and 4P capable processors and enabling the same platform that installs into a 2P server to install into a 4P server, and vice versa.

The AMD Opteron™ 6000 Series platform offers 8 or 12 processor cores per socket, for up to 48 cores in a 4P configuration. In addition, the AMD Opteron™ 6000 Series platform can achieve up to two or more times the memory bandwidth of previous-generation AMD processor-based servers[3] while staying within a similar power and thermal envelope.

Designed for consolidation and virtualization

AMD Opteron™ 6100 Series processors also include key hardware-accelerated virtualization technologies. These processor advancements complement other hardware improvements from AMD and software improvements from Microsoft that make virtualizing SQL databases like Microsoft's SQL Server 2008 R2 easier to accomplish — and able to deliver greater benefits from consolidation — than ever before.

So now the classic rationales for consolidation and virtualization — reduced power costs that lower total cost of ownership, smaller data center footprint, improved CPU utilization, easing of IT management burdens — can be applicable to SQL database servers.

What new AMD Opteron™ processors can do

Consolidating and/or virtualizing SQL Server environments works best with

- High-end processor performance that is able to tackle memory- and compute-intensive workloads with both cost- and energy-efficiency
- A highly scalable processor platform with built-in, low-overhead virtualization technologies developed in collaboration with hypervisor and virtualization software leaders.

With the arrival of AMD's Opteron™ 6000 Series platform — which powers Dell's new PowerEdge R815 server, among others — 4P servers are now within budgetary reach of mainstream businesses.

Consolidating and/or virtualizing SQL servers helps ...

- Overcome database sprawl
- Extend the life of older servers (by repurposing them)
- Speed up SQL provisioning
- Deliver high availability without clustering
- Minimize the need to migrate
- Increase agility

This matters less when a server hosts only a few virtual machines (VMs) and resource competition is minimal. But all that changes when there are more VMs than available processor cores.

More VMs mean the hypervisor must provide each VM with sufficient processor access. Thus processors have to support many more VMs as well as a hypervisor — and must perform certain functions, notably memory management and I/O, very efficiently.

AMD Opteron™ processors with AMD Virtualization™ (AMD-V™) technology accomplish this while also delivering advanced price/performance in threaded applications.

AMD Opteron™ processors with Direct Connect Architecture

By providing advantages in memory bandwidth and scalability, Direct Connect Architecture helps enable more VMs to be hosted per server and more users and transactions per VM.

AMD's Integrated Memory Controller provides the low-latency, high-bandwidth memory access essential to virtualized environments. The non-uniform memory architecture (NUMA) memory controller right on the chip allows the processor to resolve its own memory fetches rather than create delays by sending the request to a chipset component that engages a memory bus.

AMD Opteron™ processors feature HyperTransport™ technology (HT) Assist that also enables high-speed I/O to help reduce memory latency, facilitate improved resource sharing, and help increase overall system performance for virtualization workloads in multi-socket systems.

Low-overhead, high-efficiency virtualized environments with enhanced AMD-V™ 2.0

AMD Opteron™ processors with AMD-V™ featuring Rapid Virtualization Indexing with Tagged-TLB facilitates hardware-based virtual machine memory management and efficient VM switching, thus helping to reduce software overhead, maintain effective VM security boundaries, and boost both application responsiveness and the performance of virtualized applications.

AMD Extended Migration helps virtualization software achieve dynamic, seamless live migration of VMs across the entire range of available AMD Opteron™ processors to optimize system performance and help out with disaster recovery.

AMD-P power management technologies

By intelligently managing power consumption in several ways, AMD Opteron™ processors conserve energy during low-utilization cycles.

AMD PowerNow!™ technology helps reduce processor power consumption based on each core's utilization level, AMD CoolCore™ technology turns off unused parts of a processor, and the C1E power state decreases the power draw of select system functions when they're not in use.

What you need to know: Different approaches for different apps

But which approach — consolidation or virtualization — works best for SQL database servers? The short answer: It depends.

In general, applications that make good consolidation/virtualization candidates have moderate performance requirements, little active development, low machine resource utilization, and low maintenance costs. After that, much depends on an application's isolation and density requirements.

"When virtualizing," says Nathan Saunders, Database Alliance and Product Manager at Dell Computer Corp., "the intended workload is the single most significant starting point to consider. Not all workloads are candidates for virtualization, and administrators must also consider the requirements of heterogeneous application workloads."

Most consolidation/virtualization efforts involve one (or a combination) of the following three major scenarios, described here in terms of Microsoft's SQL Server.

Consolidating SQL Server databases

In this scenario, multiple applications share/store data in one SQL Server instance, and each application is contained within its own database/set of databases.

"This approach works best if the application can be modified to avoid contention issues," says Sung Hsueh, Program Manager with Microsoft's SQL Server Engine Product Team. "I recommend using SQL Server 2008 R2 because it enables greater than 64-processor support, which helps provide higher density."

In addition to the general advantages accruing from consolidation, this approach can reduce management and licensing costs (because fewer SQL instances need to be maintained). The chief disadvantage: All apps must share the same patch level, server-level objects (e.g., tempdb), and host system access level.

Consolidating SQL Server instances

When you have an instance of consolidating SQL Server, multiple applications run on a single physical server with multiple SQL Server instances, and each instance contains an application. This works well for applications that cannot be easily modified or changed and for those with unique work patterns and high utilization. Here, too, Microsoft's Sung recommends SQL Server 2008 R2 for leveraging greater than 64-processor support.

The virtues of this approach include

- Each application can be set to different patch levels, since instance binaries are isolated,
- Some resources — e.g., CPU affinity mask and max server memory settings — are isolated,
- Database system administration is isolated, and
- Each instance can be enrolled within a SQL Server Control Point for management.

The downside: Too much sharing — notably of host server Windows system admin and also of system resources (CPU, memory, I/O), which creates potential for application conflicts.

SQL Server virtualization

In this scenario, applications reside on virtual machines (VMs), and a single physical machine

hosts multiple VMs, each of which hosts a single SQL Server instance. This is well-suited for high-availability applications and, notes Sung, "It's a great fit for older applications or for achieving very low-cost migration from an old server to a new server."

Although this approach maintains as many operating systems and SQL Server images (one for each VM) as the source environment, it results in fewer physical servers that must be managed and ensures full isolation between VMs, which communicate with other servers as if they're physical machines. Also, migration from the source environment is easier, since the VM acts as a dedicated physical machine.

What's more, resources are automatically managed and optimized between multiple VMs by the Windows Server® 2008 software's Hyper-V hypervisor. Each SQL Server instance within a VM can be enrolled within a SQL Server Control Point for management, and further high-availability options are provided via Hyper-V Live Migration.

The unbeatable combo: AMD, Dell, and Microsoft SQL Server

"From the processor perspective," says Matt Kimball, Strategic Marketing Manager at AMD, "SQL is very much another workload running on Hyper-V. And our interface is to Hyper-V."

In fact, Hyper-V exploits AMD Opteron™ processor features. To help reduce both the complexity and the memory overhead of managing VMs, Hyper-V R2 employs second-level address translation (SLAT) to take advantage of AMD Opteron™ processors with Rapid Virtualization Indexing and Tagged-TLB. And Hyper-V virtual machines are supported by AMD Extended Migration. In addition, Hyper-V supports up to 64 cores and up to 1TB of physical memory. Hyper-V also utilizes the AMD Opteron™ processor's power management tools. For example, AMD PowerNow!™ technology is turned on by default in R2.

That's not all. "New to Microsoft SQL Server 2008 R2," points out Dell's Saunders, "is support for greater than 64 logical processors. Dell PowerEdge servers with the new multi-core AMD Opteron™ processors immediately exploit this flexibility."

Meanwhile, the new AMD Opteron™ 6000 Series platform delivers up to 66% faster memory[4] and nearly doubles I/O bandwidth, thanks to an additional (and faster!) T3 link[5].

AMD's Direct Connect Architecture 2.0 provides higher peak throughput and up to double the memory bandwidth (compared to previous AMD Opteron™ processor generations)[3], and integrates up to 12 cores within the same package.

Bottom line:

Consolidating and/or virtualizing SQL Server databases can improve data center efficiency and enable you to tackle database sprawl, achieve high availability, and boost agility.

To get the best results, you need the right hardware and software from vendors like AMD,

Dell, and Microsoft, who are committed to pushing the evolution of x64 virtualization so that you can reach near-native performance of the applications you run on virtual machines.

Beginning with the value 4P capabilities of the AMD Opteron™ 6000 Series platform, the AMD/Dell/Microsoft combination can help produce substantial savings. Plus with AMD-P power management technologies, points out AMD's Kimball, users can realize dramatic power efficiencies.

Finally, says Kimball, "The new version of Hyper-V supports greater memory and core counts. This means virtualized SQL environments can take full advantage of Dell's AMD technology-based 48-core servers. And this can lead to even greater performance gains."

Notes:

1 Publicly available information: See http://www.infoniac.com/hi-tech/digital-content-today-to-double-every-18-months.html.

2 Based on standard power Six-Core AMD Opteron™ processor Model 2435 1ku pricing of $989 as of 10/19/09 vs. standard power AMD Opteron™ processor Model 6172 ('Magny-Cours') 1ku planned pricing of $989 aas of March 29, 2010.

3 Based on quad channel DDR3-1333 for AMD Opteron™ 6100 Series processor vs. dual channel DDR2-800 for six-core AMD Opteron™ processor.

4 AMD Opteron™ 6100 Series processors support up to 12 DIMMs per socket vs. 6 DIMMs per socket for six-core AMD Opteron™ processor; 66% faster memory performance based on up to DDR3-1333 memory support for AMD Opteron 6100 Series processor vs. maximum DDR2-800 for six-core AMD Opteron processor.

5 I/O comparison based on 3x HyperTransport™ technology links @ up to 4.8 GT/s (up to 14.4 GT/s total bandwidth) for six-core AMD Opteron™ processor vs. 4x HyperTransport™ technology links @ up to 6.4 GT/s (up to 25.6 GT/s total bandwidth) for AMD Opteron™ 6100 Series processor.