Executive Summary

Maximizing Your Server Memory and Storage Investments with Windows Server 2012 R2

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Windows IT Pro

What's inside

- Windows Server 2012 fully leverages today's computing, network, and storage resources.
- Hyper-V virtualization enables efficient use of the vast amounts of memory on today's systems.
- Solid-state drives offer the highest levels of performance with the lowest power consumption.
- Trim functionality is critical for maintaining SSD performance.
- Storage Spaces manages storage for improved performance.
- Consider workloads, endurance needs, and power loss protection when selecting memory.

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John Savill, Windows Technical Specialist
Cameron Crandall, Senior Technology Manager, Kingston Technology SSD Product Engineering Department

Overview

On July 15, 2015, Microsoft ends support for Windows 2003. As support ends, the numerous companies still using this operating system must migrate to Windows Server 2012 or 2012 R2 to take advantage of having a fully supported operating system, as well as to ensure compliance with regulatory requirements that would be negated by using an unsupported operating system.

Since Windows 2003, Microsoft has updated the server operating system to natively support technology that is now commonplace. From virtualized systems to SSDs (solid-state drives), Windows Server 2012 and 2012 R2 are built not just to support these newer technologies, but to offer improved performance and easier use.

Organizations shouldn't just swap in Windows Server 2012 or 2012 R2. Instead, organizations should understand the benefits available with the operating system upgrade. It is also an ideal time to consider the power and high performance available with SSDs on these systems, something Kingston Technology can help organizations better understand.

Context

Windows Technical Specialist John Savill urged organizations to understand the benefits of the changes that have occurred between Windows 2003 and Windows Server 2012 and 2012 R2. Cameron Crandall, a senior technology manager at Kingston, shared a checklist that IT can use when considering which SSDs are best for their environment.

Key Takeaways

Windows Server 2012 fully leverages today's computing, network, and storage resources.

Making the jump from Windows 2003 to Windows Server 2012 or Windows Server 2012 R2 is more than just an operating system upgrade; it's an architecture upgrade. Hardware requirements have changed, as has the way Windows leverages that hardware. Organizations need to consider how best to take advantage of the benefits that come with the new operating system and new hardware.

Hardware Requirements		
	Windows 2003	Windows Server 2012/2012 R2
RAM	– Minimum: 128 MB – Recommended: 256 MB – Maximum: 4 GB (Standard); 32 GB (Enterprise)	– Minimum: 512 MB – Recommended: 2 GB – Maximum: 4 TB
Disk space	1.5 GB	32 GB
CPU	1 to 8 processors (Enterprise) 32-bit or 64-bit	Up to 64 processors; 640 logical processors (230 with Hyper-V) 64-bit only

Virtualization is a significant factor in hardware support. Unlike Windows 2003, which was mainly deployed on a physical system, Savill estimated that 70% to 80% of Windows Server 2012 implementations are deployed in virtual environments. In fact, Microsoft has built-in Hyper-V virtualization support with Windows Server 2012.

While Windows 2003 supported Remote Desktop, Windows Server 2012 builds upon the basic internal services initially offered, enabling application publishing, virtual desktop, gateway capabilities, and driverless printing.

File Classification Infrastructure (FCI) is a feature that was added to the File Server Resource Manager with the Windows 2008 R2 release. FCI looks at the contents of the files and automatically classifies files, for example, as PII (Personally Identifiable Information) or "Top Secret." Rules then drive actions applied to these files, such as application of a rights management policy, or an automatic copy to another location.

Among other Windows Server 2012 functionality that organizations may want to learn more about are Active Directory Federation Services for leveraging clouds and partners, Web Application Proxy, PowerShell, and UEFI support. These and other new and improved features may ease or remove the pain caused by manual processes or the added costs of third-party products used with 2003, as native support isn't available for what the organization does today.

Hyper-V virtualization enables efficient use of the vast amounts of memory on today's systems.

Windows Server 2012 supports up to 4 TB of memory. Yet few applications can use that much memory. Virtualized systems use this memory, and many other aspects of the hardware, more efficiently. Through virtualization, one physical system can be carved up into many smaller virtual systems with assigned amounts of memory, virtual CPU cores, and disk space.

Don't just migrate or upgrade to Windows Server 2012 and keep things the same that they were. Take time to understand what 2012 can do, and really maximize those investments.

John Savill

Hyper-V is the native virtualization offering in Windows Server 2012, and like the operating system itself, can support up to 4 TB of memory. Each virtual machine can be assigned up to 1TB of memory and 64 virtual CPUs.

Hyper-V supports NUMA (non-uniform memory access) topology pass-through. NUMA is used to increase processor speed without increasing the load on the processor bus, allowing each process to run on a core that is using the memory directly attached to the processor.

With Hyper-V, the NUMA topology is passed through to the virtual machine, enabling the virtual machine to decide where virtual processes should run to perform most efficiently. To ensure a virtual machine can start up, NUMA spanning allows allocation of memory from other NUMA nodes on the system if memory in the default node isn't available.

Dynamic memory is also supported for Hyper-V virtual machines. This functionality allows the system to intelligently allocate or take back memory as necessary based on the actual workload within the virtual machine.

Windows Server 2012 monitors ECC (error correcting code) memory pages with Predictive Failure Analysis to identify when memory pages have encountered errors. If an error threshold is exceeded, Windows hardware error architecture takes the memory page offline to decrease the risk of corruption in the application.

Solid-state drives offer the highest levels of performance with the lowest power consumption.

Traditional platter hard drives suffer from performance penalties that occur as the head seeks out pieces of data by moving around the disk. SSDs (solid-state drives) are able to offer phenomenal performance, since they have no moving parts and no seek.

SSDs have been natively supported beginning with Windows Server 2008 R2. The operating system optimizes the technology, and also prolongs the life of the drives. Some of the changes Windows Server 2012 users will see are:

- **Defragmentation is disabled.** Designed to move all blocks of a file into a continuous stream for more efficient seek, this is a pointless feature for SSDs, which don't perform seek operations. Defragmentation can also have an adverse effect on the lifetime of the SSD as there is a limit to how many times data can be written and wiped.
- **Superfetch, Prefetch, and Readyboost are disabled.** Superfetch defragmented components used for the boot sequence, and this was predominantly used by Prefetch. Readyboost relied on Superfetch to speed up the system.

My system's best possible performance is if I have a process running on a core that's using memory directly attached to that processor.

John Savill

When I think about wanting the highest levels of performance, the lowest power consumption, I think about SSDs.

John Savill

- **Partitions are created to optimize SSDs.** Now, partitions are automatically aligned to optimize SSDs.
- **BitLocker encryption is enhanced for SSDs.** BitLocker now offers an option to encrypt only those blocks where data is written. This minimizes writes and prolongs the life of the SSD.

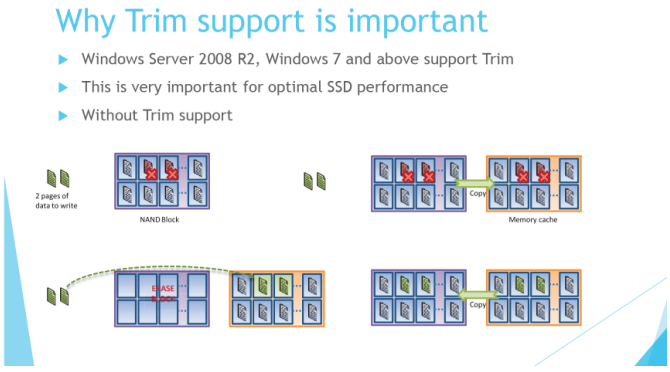
A common question is whether pagefiles should be stored on the SSD. If the system is architected properly, pagefiles are seldom used, and have a 40:1 ratio of reads to writes, which is perfect for an SSD. The typically small reads—70% are less than 4 KB—involve hopping around random access, which is handled well by SSD.

Trim functionality is critical for maintaining SSD performance.

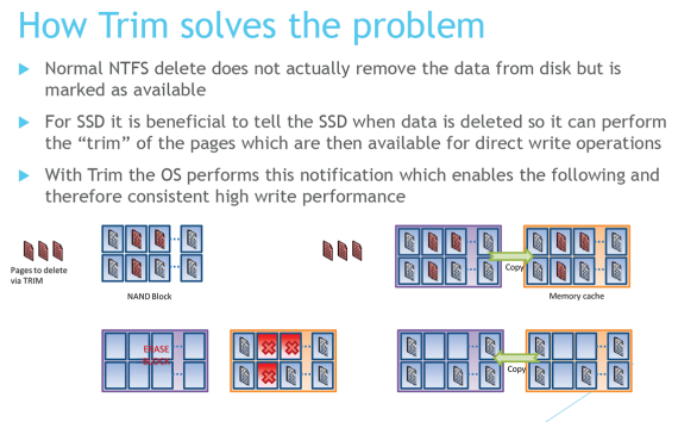
When an SSD writes to a page, it is actually writing to cells which are organized into pages. The pages are then organized into blocks. Although reading and writing happen at the page level, erase only occurs at the block level.

Windows Server 2012 supports Trim for writing and wiping. Without this functionality, the write and wipe operations would not only negatively impact performance, they would eventually fill the disk.

For example, without Trim, a system writing two pages is going to overwrite two blocks. First, the common content needs to be erased from those blocks, then the system has to copy data to the memory cache, and then it has to perform an erase operation on the entire block. The new pages are put into that memory cache area, and then written back to the entire block.



With Trim, the operating system tells the disk it is trimming away the blocks. In the background, the SSD can copy the data and remove the blocks in its own time. Unlike the previous scenario, the pages are not overwritten at that time, so those pages are available for a future write operation. This maximizes SSD performance.

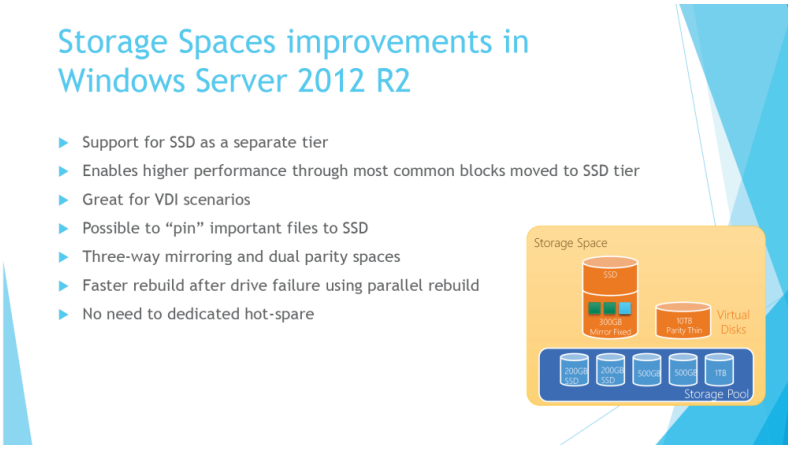


Storage Spaces manages storage for improved performance.

Storage Spaces, introduced in Windows Server 2012, is a new way to manage storage. The technology pools physical disks, and then creates spaces from those pools called "virtual disks." This storage subsystem is exposed to Windows like a disk. These systems are self-healing, thin-provisioning, and offer a number of resiliency options.

Windows Server 2012 R2 improves upon Storage Spaces, including native support for SSDs. Storage Spaces now brings to Windows the high performance usually seen in a tiered SAN.

Performance is improved as the system identifies the most commonly written and read blocks, and moves those onto the SSD tier. A write-back cache is also created, so that writes that first come into the storage space are written to the SSD first, and then the SSD can write to the hard disk drives when necessary.



Any workload with a high IO is bound to benefit from this technology. Applications like SQL Server 2012, which have functionality to optimize fast disks like SSDs, are ideal for this technology.

Even if this system is super busy, it's not going to have any real effect on my write performance.

John Savill

Consider workloads, endurance needs, and power loss protection when selecting memory.

Windows Server 2012 and 2012 R2 extend memory capabilities and provide an operating system that is very much SSD-aware, leading to better performance for SSD users.

When selecting an SSD, Kingston Technology suggests following a checklist of considerations.

Expected Workload	What is the expected workload, and what needs to run on the SSD? – Database? – TempDB? – Log files? – Caching/tiering?
Endurance Needs	Is the environment high read or is it high write?
Power loss protection	Is power loss protection needed for the SSD?

Determine the expected workload for the SSD. Workloads for client systems are similar to one another from day to day, but servers can differ greatly. Workloads can be high read, high write, and have different bottlenecks. Some organizations want to put databases directly on the SSDs; others are looking to speed up TempDBs or log files with SSDs. These different needs will impact the recommended SSDs.

Organizations should also understand the endurance requirement. Is the environment high read or high write? A high-quality client drive may be acceptable for the workload the server is doing. In high write situations, though, SSDs with higher P/E cycles and built-in NAND flash memory are required to ensure a lengthy SSD life, since these devices can be written to 10 times more than a client level drive.

The server class of SSDs use 10,000 to 30,000 P/E cycles for the flash. A 30,000 P/E cycle drive used in a mainly read environment will last much longer—probably beyond the useful life of the system—than one that is written to excessively. Tools are available that can monitor the health and life expectancy of the SSD; Kingston SSDs include a smart attribute called SSD Life Left that lets users see how much life remains on the drive.

Power loss protection can be of concern for some organizations. Companies with redundant power supplies and built-in UPS might not be concerned about power loss protection. Organizations that have an unstable power supply may want to pay a little more for power loss protection. That way, if the power goes out during IO, writes are committed to the flash and then the drive is shut down properly.

We've been enjoying the performance benefits of SSDs for several years. The host operating systems being aware of SSDs and being able to make enhancements to increase performance and extend the life of the SSD only makes the solution better.

Cameron Crandall

Kingston helps organizations find the right SSDs for their needs by putting a set of SSDs into the company's environment, and then using smart tools to extract data. They can determine how long an SSD will last in a specific environment under a specific workload.

Other Important Points

An organization needs to plan the right memory strategy for their windows server environment. It is important to determine the memory configuration that relates to this strategy:

- **Maximize for performance.** Take into consideration memory ranking. Look for a balanced configuration and understand the best way to configure memory modules for the highest bandwidth.
- **Maximize for capacity.** Buy the highest capacity modules that can be afforded. This strategy considers future needs, offering headroom to grow and expand the capabilities of the server.
- **Minimize power consumption.** Purchase low-voltage DIMMs, which maximize power use, rather than standard-voltage DIMMs.
- **Determining memory.** To find the right memory configuration for a server, visit Kingston's System-Specific Server Memory site.
- **Configuration consultations.** Kingston offers free configuration consultations through the Ask An Expert option, available on its website.

Really try and assess your workload and your needs in terms of what is the right SSD for your application. With that, you'll be able to configure cost-effective high-speed storage solutions.

Cameron Crandall

Biographies

John Savill

Windows Technical Specialist

John Savill is a Windows technical specialist, an 11-time MVP, and an MCSE for Private Cloud and Server Infrastructure 2012. He's also ITIL certified and a CISSP. John is the author of the popular "FAQ for Windows" and a senior contributing editor to *Windows IT Pro*, as well as the author of *Microsoft Virtualization Secrets* (Wiley) and *Mastering Hyper-V 2012 R2 with System Center and Azure* (Wiley). John's blog is available at Savilltech.com.

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Cameron Crandall currently serves as a Senior Technology Manager with Kingston Technology's SSD Product Engineering Department. In addition to helping lead the engineering efforts for new and current product offerings, Mr. Crandall serves as a technical advisor for Kingston's sales, marketing, and public relations departments. Mr. Crandall is in his 17th year at Kingston, and in that time has held several positions including technical support manager and field applications engineer. He also served as business development manager for Kingston's Storage Products Division where they designed, built, and sold SCSI and Fiber Channel disk arrays. Mr. Crandall currently resides in Orange, Calif.