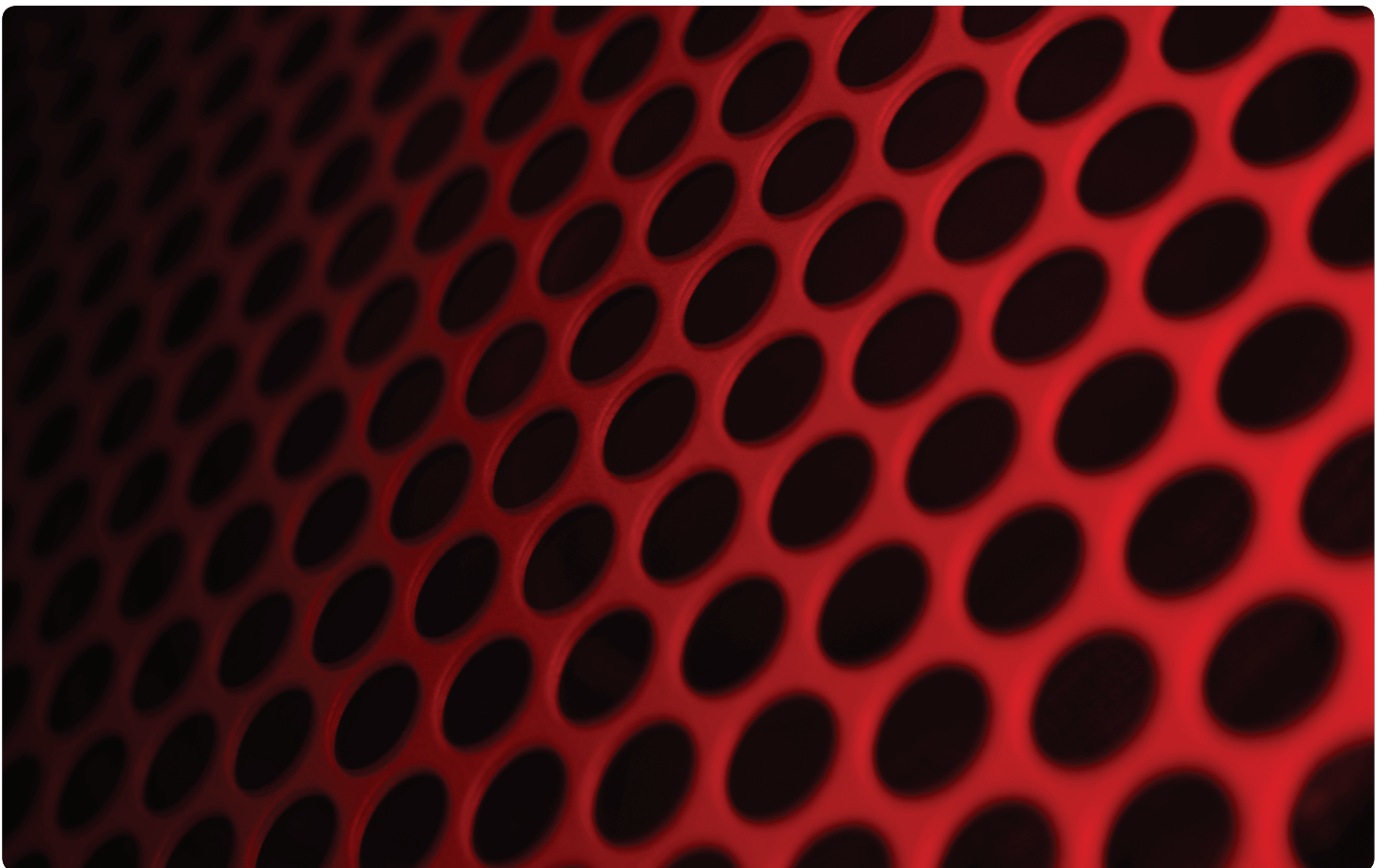


# Windows Server 2016 Memory and Storage Expert Guide

Memory and storage feature enhancements in Windows Server 2016



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## Introduction

As the data centre has evolved, technologies have emerged to help IT professionals worry less about the underlying hardware on which their services rely.

For example, virtualisation has largely abstracted away the hardware layer, giving Windows® administrators a great deal of control and flexibility in the software-based hypervisor layer. As a result of virtualisation utilising previously unused compute and memory capacity, data centre density and efficiency have improved greatly in the recent past.

### A Convergence Trend

Lately, there has been an IT trend toward the convergence of storage, networking and compute resources in the software-defined data centre, and these once largely separate components have become more tightly integrated. They now work together more cohesively than in the traditional model, which had more separate, siloed components.

### Windows Server 2016 Enhancements

Microsoft Windows Server 2016 was developed to continue this trend by introducing features and improvements that enable administrators to do even more with less. Microsoft's latest server OS helps IT move further away from a model of individual physical servers running single applications and toward a more flexible, distributed data centre platform, one that allows for the automation of storage, memory, compute and networking resources, and for workloads to move seamlessly between servers or geographical locations, depending on demand.

Windows Server 2016 offers enhancements in the areas of virtualisation, software-defined storage and networking, security and management. In addition, Windows Server 2016 brings new features, including Windows Server Containers, Nano Server and Storage Replica. The OS also greatly improves upon features such as Storage Spaces Direct, Storage QoS (quality of service), memory runtime resize and more.

- Thanks to Storage Spaces Direct, Windows Server 2016 can provide a highly available storage system at a much lower cost using hardware that organisations probably already have.
- In certain situations, IT departments can achieve up to 93% lower VHD size with de-duplication enabled.<sup>1</sup>
- IT admins have more control over all components in their environments, and management and automation of the entire server environment is easier than with previous OSes.

The whitepaper introduces several important Microsoft server OS storage and memory enhancements that give Windows administrators access to advanced functionality and help IT departments save money, thanks to cost-saving new features that once existed only in specialised hardware. Now they're available to everyone via OS, enabling IT professionals to get maximum return on investment out of the hardware they already have – and to budget effectively for future needs.

## Introducing Windows Server 2016

While Windows Server 2016 offers a lot more functionality, it has the same minimum requirements and upper limits as its predecessor. Staying with these same limits isn't a big deal because most companies would be hard pressed to find a single application that exceeds any of these maximums.

### Windows Server 2016 Minimum Requirements

- 1.4 GHz 64-bit processor
- 512 MB RAM
- 32 GB disk space
- Gigabit (10/100/1000baseT) Ethernet adapter

### Windows Server 2016 Maximum Supported Memory and VM Limits

- 24 TB max RAM per server host
- Up to 1,024 VMs per host
- 64 vCPU per VM
- Up to 12 TB RAM per VM
- 320 LP per host (with Hyper-V enabled, 640 if it's not)
- 64 TB VHDX (virtual hard disk used with Hyper-V)

For IT professionals considering an upgrade to Windows Server 2016, it's important to understand the new capabilities in order to fully take advantage of its features and make an informed decision—as well as to get the best return on OS investment.

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## Key Memory feature

### VM Runtime Resize

To keep reboots to a minimum, a new feature on Windows Server 2016 hosts known as Runtime Resize will allow administrators to increase or decrease memory allocated to a virtual machine without any VM downtime, even if Dynamic Memory is disabled.

Runtime Resize provides hot add and removes memory capabilities for virtual machines and works on both Generation 1 and Generation 2 VMs (which require a guest OS newer than Windows Server 2012 or Windows 8). There are a couple of limits: The memory allocated to a running VM can't be decreased to a level below current demand or increased to a level higher than available physical system memory.

To change the amount of static memory allocated to a VM, you can go into the virtual machine settings and change the amount of "Startup RAM" associated with the VM.

Speaking of Dynamic Memory, just as in previous versions of the OS (starting with Windows Server 2008 R2 SP1), this feature enables a minimum and maximum amount of memory to be specified for individual VMs, and this memory allocation intelligently scales as demand increases or decreases. This can go a long way toward ensuring memory resources are used efficiently. As in Windows Server 2012/R2 versions, in Windows Server 2016 you can increase the minimum and maximum limits on Dynamic Memory while the VM is running.

As a side note, starting in Windows Server 2016 you can also hot add or remove virtual network interface cards (NICs) from a VM without the need to reboot. This feature is on Generation 2 VMs only, and works with supported Windows or Linux OSes.

Note that the features mentioned above apply to Hyper-V virtual machines. Depending on hardware vendor support, Windows Server Enterprise and Data Center editions (starting with Windows Server 2003 SP1) also support hot-add of physical memory. This allows memory to be added to a running operating system without requiring any application downtime or for the physical system to be shut down.

## Key Storage features

### Storage spaces direct

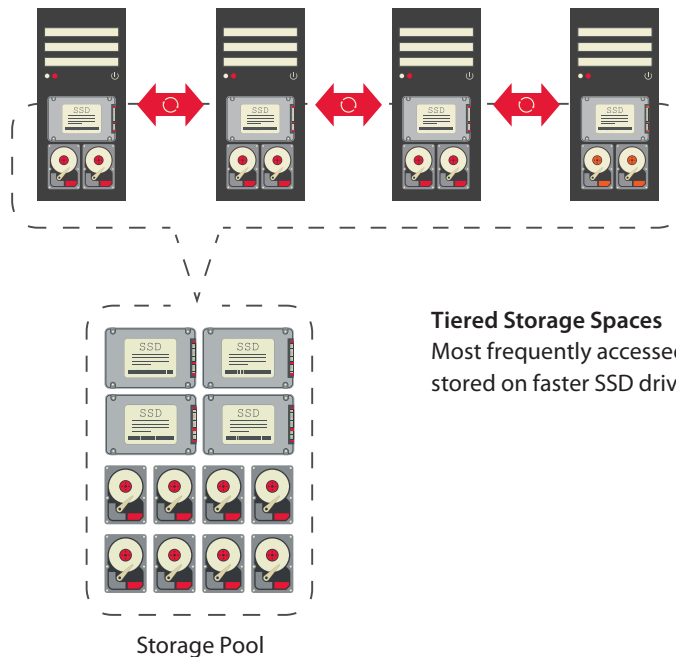
Keeping within the theme of doing more with less, an important storage feature in Windows Server 2016 is Storage Spaces Direct, which allows IT admins to build a scale-out, redundant, shared storage system using inexpensive, commodity "just a bunch of disk" (JBOD) arrays or commodity servers with local internal server storage, or a combination of both.

With Storage Spaces Direct, instead of having intelligence that enables advanced storage functionality located in a relatively expensive physical storage controller as part of a SAN array, this logic resides in the OS. Thanks to Storage Spaces Direct, Windows Server 2016 can provide a highly available storage system at a much lower cost using hardware organizations probably already have. In other words, Windows Server 2016 gives IT pros and users access to fully replicated storage that's redundant with full parity, all on standard x86 commodity servers and storage that's been transformed through software into a high-performance, redundant infrastructure (leading some to use the term "virtual SAN" when referring to the class of similar technologies).

***Thanks to Storage Spaces Direct, Windows Server 2016 can provide a highly available storage system at a much lower cost using hardware organizations probably already have.***

Storage Spaces Direct scale-out clusters provide the equivalent of RAID across servers, with volumes accessed as a file share tied together through the SMB3 network infrastructure with the benefit of access control list (ACL) permissions. This makes it easy to assign LUNs to servers via permissions, simplifying enterprise storage. With this new technology, there might be less need for expensive external storage for many use cases, and IT professionals don't need to be storage experts or have much experience with SANs, iSCSI, or Fibre Channel switches.

### Storage Spaces Direct



Storage Spaces Direct requires a minimum of four storage nodes, and in addition to fault tolerance and high availability, it provides tiered storage and deduplication functionality.

Storage Spaces Direct can be deployed in a variety of ways ranging from completely separated file and Hyper-V clusters and storage arrays, to a fully hyperconverged box where disks, file servers, and hyper-v are all contained within a single node.

- Separate file servers, JBOD arrays, and Hyper-V clusters
- Converged - Disks in scale-out file server cluster working with a separate Hyper-V cluster
- Hyperconverged - Local disks, file server, and Hyper-V all-in-one server node

Storage tiering is a very interesting feature of Storage Spaces Direct that enables high storage performance by allowing administrators to combine a mix of high-performance and high-capacity HDDs and SSDs in a single virtual hard drive (VHD) to meet performance demand from intensive workloads—without spending too much to meet capacity needs. Windows Server 2016 accomplishes this by running more demanding applications on faster flash drives, since storage performance is often the bottleneck in virtualized environments. Storage Spaces Direct automatically handles tiering based on which data is “hot” or most frequently accessed.

## Storage QoS

Related to performance, for IT departments that need to ensure that specific high priority VMs or services get the resources they need, storage QoS (Quality of Service) enables administrators to granularly manage policies applied to individual VHDs, services or tenants.

This new feature in Windows Server 2016 helps eliminate the “noisy neighbor” problem in virtualization in which one greedy VM takes more than its fair share of resources, here represented by IOPS (input/output operations per second). While this feature was introduced in earnest in Windows Server 2012, it has been significantly improved in Windows Server 2016 because QoS policy can now be set so the file server and VMs work collaboratively. In previous versions, policies could only be set at the VM level.

IT admins can set QoS policies across multiple VMs using either PowerShell or a GUI. There are two policy types:

- Single-instance policies divide a predefined number of IOPS amongst multiple VMs. For example, with a shared single-instance profile for 200 IOPS that’s applied to two VMs, they might each receive 100 IOPS.
- Multi-instance policies set explicit limits that are the same across all the VMs the policy is applied to. For example, if you set a multi-instance QoS policy that allocates 200 IOPS to two VMs, they would both get the full 200 IOPS.

### Types of QoS Policies

#### Single-Instance

- Resources distributed among VMs
- Ideal for representing a clustered workload, application or tenant



#### Multi-Instance

- All VMs perform the same
- Ideal for creating per-VM performance tiers



## Deduplication

Another storage aspect that's been enhanced in Windows Server 2016 is deduplication. Windows Server 2012 had a limit that encouraged IT professionals to distribute files across multiple volumes with a ~10 TB limit and a single job per volume. While it was effective, it was a bit slow; it could take days to dedupe a large volume.

Deduplication is much faster and more flexible in Windows Server 2016. The maximum volume size for dedupe has been increased to 64 TB, and the dedupe process is now multi-threaded per volume, where all files are optimized in parallel with load balancing to deliver a much faster and more seamless process. In certain situations IT departments can achieve up to a 93% lower VHD size with deduplication enabled.<sup>1</sup>

### Deduplication in Windows Server 2016:

Capability	Windows Server 2012 R2	Windows Server 2016
Volume sizing	To scale, distribute files across multiple volumes no larger than 10 TB	Use any size up to 64 TB
Optimization	<ul style="list-style-type: none"><li>• Single job per volume</li><li>• Single CPU and single I/O queue</li></ul>	<ul style="list-style-type: none"><li>• Multi-threaded per volume</li><li>• All files optimized in parallel</li><li>• Auto load balancing of input queues and resources</li></ul>
Backup support	Manual configuration per volume and per node using PowerShell	Setting is an integrated usage type through UI or with PowerShell

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## Storage Replica

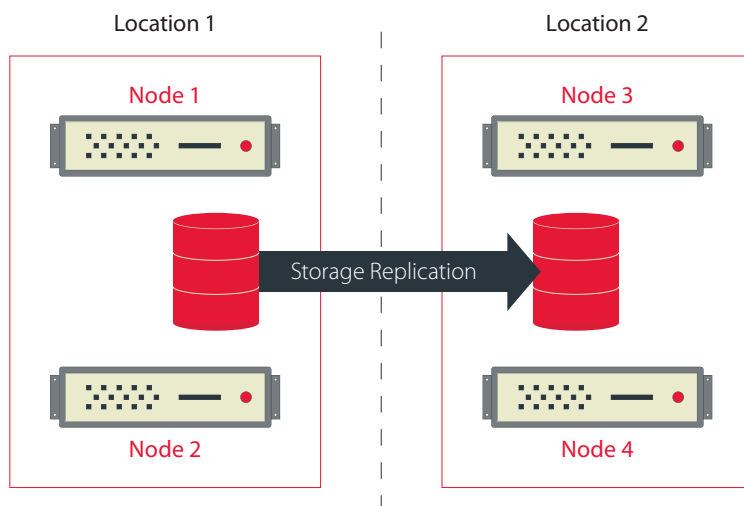
Another storage technology to be aware of in Windows Server 2016 is Storage Replica, which provides block-level, hardware agnostic, synchronous or asynchronous replication between servers or clusters for disaster recovery, as well as the ability to fail over a cluster between sites.

IT departments can replicate volumes locally or across different geographical locations with stretch clusters; these include nodes in different physical locations that are part of the same cluster, yet still provide synchronous, high availability.

Synchronous mode is recommended for those with a fast connection—1 Gbps network or better, which can be a challenge for stretch clusters across long distances. In early tests, stretch clusters were found to be effective within distances of 30 km or so. On the other hand, asynchronous replication allows site extension at greater distances, although there is an increased possibility of data loss.

### Stretch Cluster

- A single storage cluster that spans geographies
- Automatic failover, synchronous replication
- Storage replica over SMB3 protocol





## Putting all the pieces together

Windows Server 2016 represents a step toward a more seamlessly integrated data center environment where storage, compute, and networking resources don't exist in silos, but instead work together seamlessly in a software-defined data center that can also easily integrate with the cloud.

With the new OS, file servers are built with advanced storage technology in mind, data is more redundant and resilient, IT admins have more control over all components in their environments, and management and automation of the entire server environment is easier than with previous OSes. Additionally, because all of these features are enabled even on standard servers and storage, organizations can take advantage of advanced functionalities at a much lower cost than before.

Windows Server 2016 represents a step toward the more agile, responsive, resilient, high-performance and distributed IT environment of the future where workloads will be able to easily get the resources they need when they need them, scale to meet demand, migrate to hosts across geographies, or utilize the public cloud.

In the future, with OSes like Windows Server 2016, organizations will be able to do more with less, worry less about small details, and take a higher-level, holistic perspective instead of getting bogged down by low-level technical details. Who knows what all is possible as the IT and storage technology that was once prohibitively expensive becomes accessible to everyone.

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