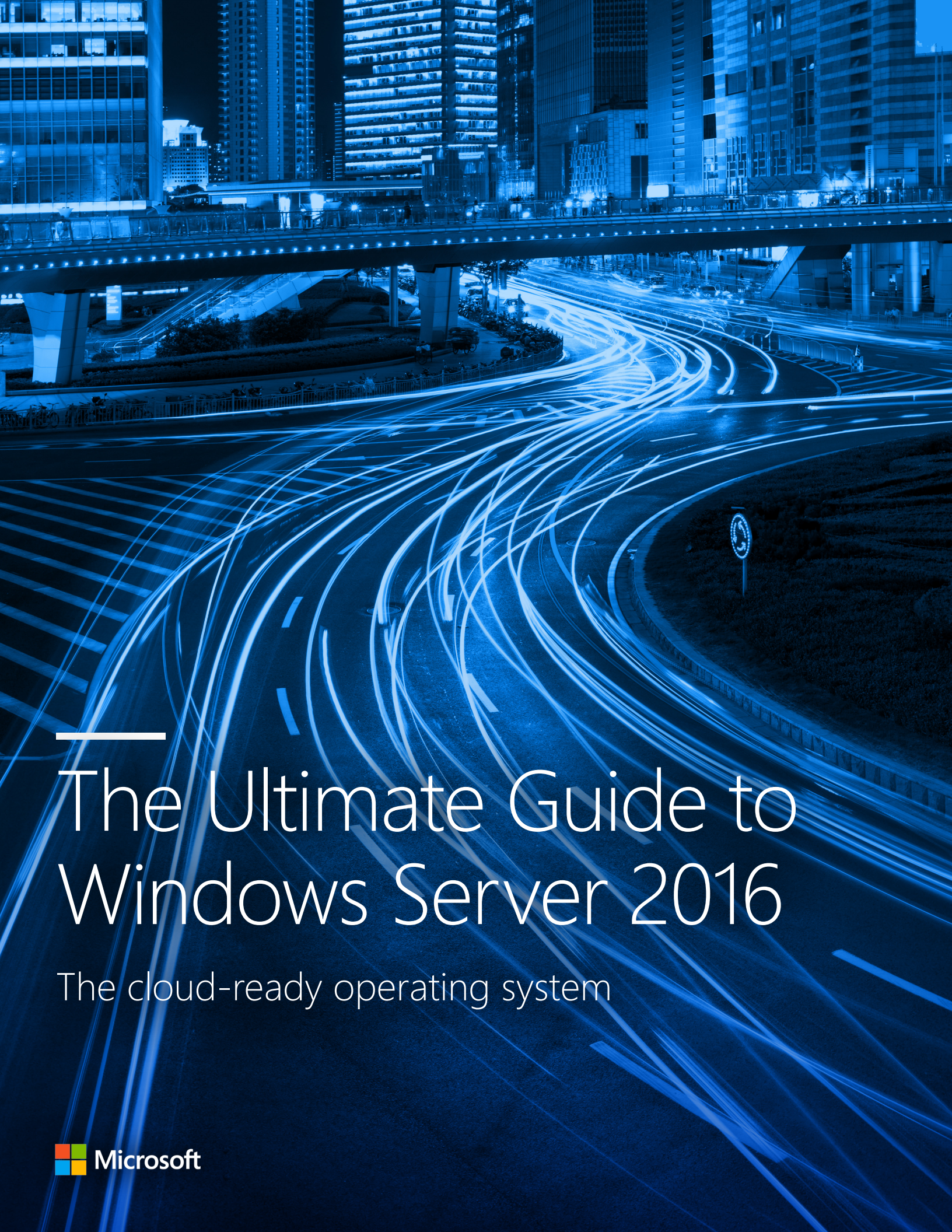

The Ultimate Guide to Windows Server 2016

The cloud-ready operating system

Microsoft

Introduction

IT organizations are expected to do more with less, but an aging infrastructure with little automation becomes a hindrance to moving forward. Meanwhile, security breaches make front page news and reputations suffer. As if that weren't enough, executives and IT managers also need to support the ability of developers to build business-enabling apps and services that work on-premises or in any cloud.

How does an organization balance this array of competing needs and position itself to better respond to market changes?

When an organization moves to Windows Server 2016, it gains an operating system that delivers layers of security for the applications and infrastructure that power its business. To support efficiency and agility, Windows Server 2016 is packed with software-defined datacenter (SDDC) technologies inspired by Microsoft Azure. And while security and efficiencies can help keep the lights on, it's innovative applications that can change industries. Window Server 2016 is built for this type of innovation. Organizations gain access to technologies that re-invigorate the apps they run today and set them up to build ground-breaking new applications using containers and microservices architectures.

Build multiple layers of active security

In today's business environment, cyberattacks have become a routine occurrence as companies of all sizes, across all industries, fall victim to hackers. The attacker profile has grown beyond independent actors, and now includes organized crime, nation states, and terror groups. The cost of security breaches continues to rise as cyber thieves target companies with personal data and intellectual property they can use or resell and interrupt businesses for profit or malicious intent. Numerous companies and government agencies are publicly embarrassed for failing to protect themselves and their customers.

A good firewall and anti-malware services are no longer sufficient to keep the bad guys out. With ever-evolving threats and higher stakes, organizations need to use more advanced methods to help prevent and detect attacks. A sophisticated security plan requires multiple layers of security to detect deviations and enable fast response to signs of infrastructure compromise.

The server operating system sits at a strategic layer in an organization's infrastructure, affording new opportunities to create layers of protection from attacks. Protection at the identity, OS, and virtualization layers in Windows Server 2016 help disrupt standard attacker toolkits and isolate vulnerable targets, making the server OS an active participant in its own defense.

The security features in Windows Server 2016 help slow down attacker progress within the environment by protecting administrator credentials and alerting administrators to malicious activity. Even if an attacker gains a foothold in an organization's environment, Windows Server 2016 security can help slow down and detect the breach.

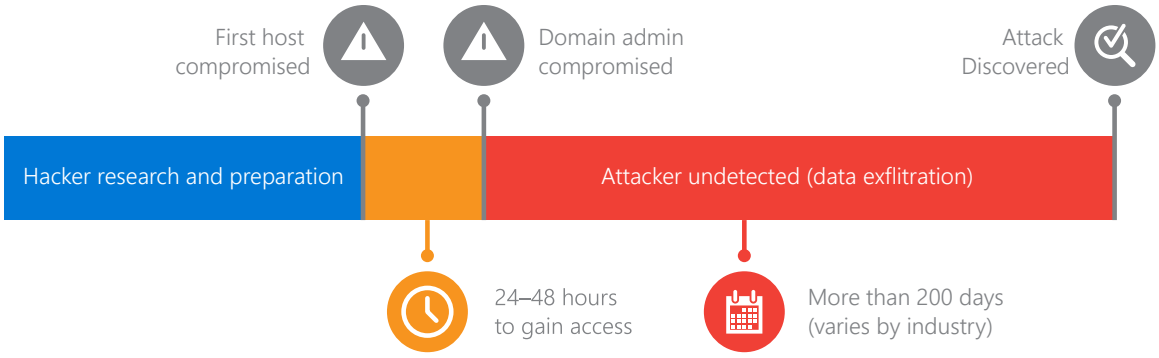

Figure 1: Attackers only need 24-48 hours to compromise an organization. Cybercriminals tend to lurk in breached environments for far too long before being detected—a median of 205 days in 2014.

To get into an organization's network, attackers frequently target identity vulnerabilities. That's what happened with health insurance giant Anthem Inc., which said hackers infiltrated a database containing records of as many as 80 million people. In another identity breach, hackers penetrated the systems of health insurance provider Premera Blue Cross, putting at risk the personal information of 11 million people.

Windows Server 2016 can mitigate threats, help secure data, meet compliance goals, and keep businesses from becoming hacking victims. Several credential isolation and threat defense capabilities are activated upon deployment, giving organizations new layers of protection against certain threats.

The following is an overview of typical organizational security objectives and how Windows Server 2016 can help.

Enterprises need to:	Example threat:	Windows Server 2016 helps:
Protect admin credentials	A Pass-the-Hash attack provides an attacker with admin credentials on a hospital network, which the attacker uses to access confidential patient data.	Provide **Just Enough Administration** and **Just-in-Time Administration** to help ensure attackers can't access critical data, even if they have compromised admin credentials. **Credential Guard** helps prevent admin credentials from being stolen by Pass-the-Hash and Pass-the-Ticket attacks. **Remote Credential Guard** delivers Single Sign On for Remote Desktop Protocol (RDP) sessions, eliminating the need to pass credentials to the RDP host and the potential for compromise on the host.
Protect servers, detect threats and respond in time	Ransomware on university servers locks users away from critical student and research data—until a ransom is paid to the attacker.	Help ensure only permitted binaries are executed with **Device Guard**. Help protect against classes of memory corruption attacks with **Control Flow Guard**. **Windows Defender** also helps protect against known vulnerabilities without impacting server roles (such as web servers).
	A line-of-business application developer downloads code from the public internet to integrate into her application. The downloaded code includes malware that can track activity in other containers through the shared kernel.	Isolate containerized applications using **Hyper-V containers** without requiring any changes to the container image. Minimize the attack surface further with the just-enough OS deployment capabilities of **Nano Server.**
Quickly identify malicious behavior	Malware tries to access the credential manager on a Windows server to gain access to user credentials.	Optimize security auditing with **Enhanced Logging** for threat detection. This includes providing auditing access to kernel and other sensitive processes—detailed information which helps **Microsoft Operations Management Suite** (OMS), a security and information event management system, provide intelligence on potential breaches through its **Log Analytics** feature.
Virtualize without compromising security	Attacker compromises fabric admin credentials at a bank, giving him access to virtualized Active Directory Domain Controllers and SQL Server databases where client account information is stored.	Create **Shielded Virtual Machines**—Generation 2 VMs that have a virtual TPM, are encrypted using BitLocker, and can run only on approved hosts in the fabric. **Host Guardian Service** requires every host to attest to its security health before Shielded Virtual Machines will boot or migrate.

Move to software-defined infrastructure

Datacenters are expensive and complicated. As data traffic continues to grow, IT organizations struggle to contain costs. It no longer makes sense to use specialized hardware and proprietary solutions that add to datacenter complexity. As companies continue to try and squeeze every last bit of savings from server virtualization, many might be wondering what's next.

For many organizations, it's the cloud. Cloud models continue to gain more appeal as organizations find out how fast and easily they can use the cloud to scale up and down to meet business needs. One of the world's largest clouds is Microsoft Azure, powered by datacenters around the world that run on Windows Server and industry-standard hardware. By applying lessons learned

from Azure to the design of Windows Server 2016, Microsoft can help customers benefit from some of the same cloud efficiencies in their own datacenters.

For some organizations, this requires reconsidering the role of hardware and software in operations. A software-defined datacenter evolves the datacenter model to achieve cost-savings and flexibility by using technologies that move control of compute power, storage, and networks from the hardware to the software. With Windows Server 2016, customers benefit from technologies inspired by and proven in Microsoft Azure.

One of the fastest ways to gain cloud efficiencies with Windows Server 2016 is with the Nano Server installation option. Nano Server is a deep rethink of server architecture based on lessons learned with Azure datacenters. The result is a new lean cloud host and application development platform that's a fraction of the size of the Windows Server Core installation option. Its small size helps to reduce security attack risks, achieve quicker reboots, and significantly reduce deployment time and resource consumption.

Following is an overview of how enterprises can improve efficiency with software-defined capabilities using Windows Server 2016.

Enterprises need to:	Example challenge:	Windows Server 2016 helps:
Improve server density	As traffic increases at an online business, admins want to launch additional VMs with faster boot times.	Use the lightweight "just enough OS" **Nano Server** installation option for a smaller footprint and faster boot times. Bring the density of containers into the datacenter to reduce resource usage with Windows Server 2016. Windows Server containers are an operating system virtualization method used to separate applications or services from other services running on the same container host. **Windows Server containers** offer greater density; **Hyper-V containers** add greater isolation, useful for multi-tenant situations.
Reduce storage cost structure	A video studio relies on highly available clustered storage area networks (SANs) and network attached storage (NAS) arrays, which are costly to purchase and maintain.	Build highly available storage at a fraction of the cost of SAN or NAS using **Storage Spaces Direct** and industry-standard servers with local storage and Ethernet. Eliminate expensive hardware and complexity and gain the ability to manage by policy, automation, and orchestration, versus manual and static configurations.
Gain scale, flexibility for networks, workloads	An organization wants to improve its dev and test capabilities by using virtual networks to test apps with the same services available in the production network.	A **virtual network** logically segments a network for applications and is defined by the application owner with its isolated address space. The virtual network is the basis for automated network functions controlled by the **Network Controller**, including automatically configured routing, security policies, and third-party technologies that can run in a Hyper-V VM. The Network Controller and **virtual switch** ensure that as a VM moves from location to location—including from virtual to physical network—the network settings (address space, security policies, load balancer, appliances) move with it.
Isolate and help protect virtual workloads	A healthcare provider wants to help protect patient information and isolate patient records from the web server facing the public.	Help protect virtual machines using the **Shielded Virtual Machines** feature which encrypts VMs with BitLocker and helps to ensure they run only on hosts approved by the **Host Guardian Service**. Even if a Shielded Virtual Machine leaks out of the healthcare provider (whether malicious or accidental) the Shielded Virtual Machine will not run and remain encrypted. Segment networks to meet security needs and protect workloads using a **distributed firewall** and **security groups**.

Resilient compute

Underpinning the software-defined capabilities in Windows Server 2016 are the virtualization capabilities of its Hyper-V hypervisor. Hyper-V in Windows Server supports an enterprise-level virtualized server computing environment to create and manage virtual machines. Organizations can run multiple operating systems on one physical computer and isolate the operating systems from each other to improve the efficiency of computing resources and free up hardware resources.

Hyper-V's continued refinements and its proven ability to handle large workloads has won over numerous organizations. The latest version with Windows Server 2016 includes significant gains in Host and Guest CPU and memory scale, the ability to use graphics processing unit (GPU) and Non-Volatile Memory Express (NVMe) resources within a virtual machine, along with industry leading networking and storage technologies. For example, organizations can easily migrate a Hyper-V workload from on-premises to a Windows Server VM in Azure, or move virtualized networks between locations—including from virtual to physical networks—along with network settings.

With Hyper-V, IT organizations can run a variety of guest operating systems—Windows, Linux, and FreeBSD—in a single virtualization infrastructure. Microsoft contributes code to Linux and FreeBSD and works with vendors and communities to ensure that these guests achieve production-level performance and can take advantage of sophisticated Hyper-V features, such as online backup, dynamic memory, and Generation 2 VMs.

Separately, customers running Windows Server 2012 or Windows Server 2012 R2 can upgrade infrastructure clusters to Windows Server 2016 with zero downtime for Hyper-V or Scale-out file server workloads and without requiring new hardware, using the Mixed OS Mode cluster capability.

For organizations that want to reduce the datacenter footprint and increase VM density, the lightweight Nano Server installation option delivers an image that is 25x smaller than the Windows Server 2016 Server with Desktop Experience installation option.

	Windows Server 2012/2012 R2 Standard and Datacenter	**Windows Server 2016** Standard and Datacenter
PHYSICAL (HOST) MEMORY SUPPORT	Up to 4TB per physical server	Up to 24TB per physical server (6x)
PHYSICAL (HOST) LOGICAL PROCESSOR SUPPORT	Up to 320 LPs	Up to 512 LPs
VIRTUAL MACHINE MEMORY SUPPORT	Up to 1TB per VM	Up to 12TB per VM (12x)
VIRTUAL MACHINE VIRTUAL PROCESSOR SUPPORT	Up to 64 VPs per VM	Up to 240 VPs per VM (3.75x)

Figure 2: New host and guest scalability makes it more attractive for organizations to virtualize even the largest, most mission critical workloads on Hyper-V, which is included with Windows Server 2016.

Affordable high-performance storage

Traditional enterprise storage solutions come with multiple costs, including a complex stack that involves proprietary cabling and communications protocols, expensive controller hardware and disks, and the need for specialized software and IT skills to configure and manage replication, failover, and provisioning. Capital costs and operating expenses can drop dramatically as organizations reduce reliance on specialized infrastructure and IT admins use familiar software to manage storage.

In keeping with Microsoft's commitment to customer choice, organizations do not need to choose one storage model over another. Windows Server 2016, like Windows Server 2012, is hardware-agnostic, and works with multiple storage configurations, such as direct-attached storage (DAS), storage area networks (SANs) and network attached storage (NAS) arrays.

Customers also can create lower-cost storage that takes advantage of low-cost local flash storage and Windows Server 2016 smoking-fast networking technologies, such as Remote Direct Memory Access (RDMA). With the Windows Server 2016 Storage Spaces Direct feature, organizations can use industry-standard servers to build highly available, scalable software-defined storage. They can use storage devices not previously possible, including lower-cost and higher-performance Serial Advanced Technology Attachment (SATA) and NVMe solid-state drives. Beyond cost savings, this approach helps simplify operations and increases scalability.

The Windows Server solution also features ease of graphical management for individual nodes and clusters through Failover Cluster Manager and includes comprehensive, large-scale scripting options through PowerShell.

Many customers increasingly want to achieve the economic and simplification benefits of a hyper-converged infrastructure, which brings together storage and compute on low-cost hardware. Large-scale private and hosted clouds, on the other hand, typically prefer the flexibility to scale compute and storage independently. Windows Server software-defined storage enables both models for customer flexibility.

For larger private or hosted clouds, having a

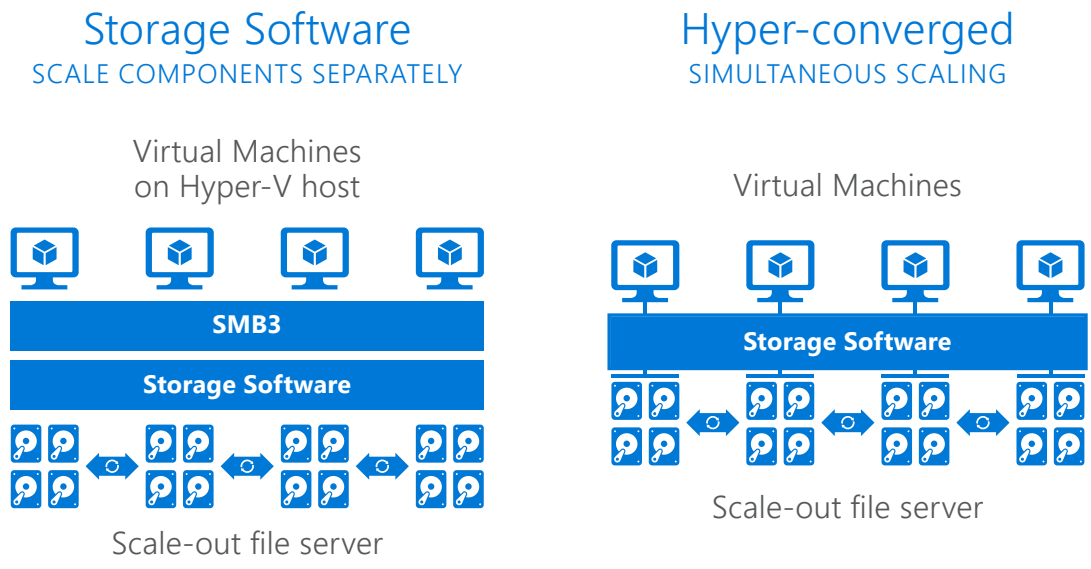

Figure 3: Windows Server 2016 supports both converged and hyper-converged scenarios. The converged, or disaggregated scenario, separates Hyper-V servers from the Storage Spaces Direct servers, enabling scaling of compute separate from storage. The hyper-converged deployment scenario places the Hyper-V (compute) and Storage Spaces Direct (storage) components on the same cluster. A virtual machine's files are stored on local Cluster Shared Volume, which enables scaling Hyper-V compute clusters together with the storage it is using.

converged, or disaggregated, architecture to scale compute and storage separately provides the greatest levels of flexibility needed for large scale deployments. For on-premises converged storage, customers can run Hyper-V over SMB to either a third-party NAS device, or to a software-defined storage solution with a Scale-out file server as a NAS head that is backed by either Storage Spaces Direct or Storage Spaces with shared "just a bunch of disks" (JBOD) enclosures and hard drives. To avoid the use of expensive host bus adapters in each compute node, customers can use low-cost Ethernet or InfiniBand as the storage fabric.

Since Windows Server is hardware agnostic, organizations do not need to choose one storage model over another.

Used in a hyper-converged configuration, Storage Spaces Direct seamlessly integrates with the features in the Windows Server software-defined storage stack, including Clustered Shared Volume File System and Storage Spaces and Failover Clustering. Hyper-converged is perfect for branch office, remote office, and small or medium-sized businesses.

Windows Server 2016 also provides a single-vendor disaster recovery solution for planned and unplanned outages of mission-critical workloads. Windows Server 2016 offers an end-to-end solution for storage, virtualization, and clustering with technologies such as Hyper-V Replica, Storage Replica, Storage Spaces, Cluster, Scale-out file server, SMB3 connectivity, data deduplication, and Resilient File System or NTFS.

Storage Replica enables storage-agnostic, block-level, synchronous replication between servers or clusters for disaster recovery, as well as stretching of a failover cluster between sites. Synchronous replication enables mirroring of data in physical sites with crash-consistent volumes to ensure zero data loss at the file-system level. Asynchronous replication allows site extension beyond metropolitan ranges with the possibility of data loss.

Azure-Inspired Networking

In a software-defined datacenter, network functions that are typically performed by hardware appliances—including load balancers, firewalls, routers, and switches—are increasingly deployed as virtual appliances. Virtual appliances are dynamic and easy to change because they are pre-built, customized virtual machines. Network function virtualization is a natural progression of server virtualization and network virtualization, and emerging virtual appliances are helping define a new market.

All these networking virtual appliances, however, need a command center. In Windows Server 2016, the Network Controller takes on this central role. The Network Controller offers a central point of automation to manage, configure, monitor, and troubleshoot both the virtual and physical network infrastructure. It replaces the need to manually configure hundreds or thousands of network devices and services. Use the Network Controller with PowerShell, System Center Virtual Machine Manager, or the RESTful API to manage the following network capabilities:

Virtual networking

- BYO address space
- Distributed routing
- VXLAN and NVGRE

Network security

- Distributed firewall
- Network Security Groups
- BYO virtual appliances via user-defined routing or mirroring

Robust gateways

- M:N availability model
- Multi-tenancy for all modes of operation
- BGP Transit Routing

Software load balancing

- L4 load balancing (N-S and E-W) with DSR NAT
- For tenants and cloud based infrastructure

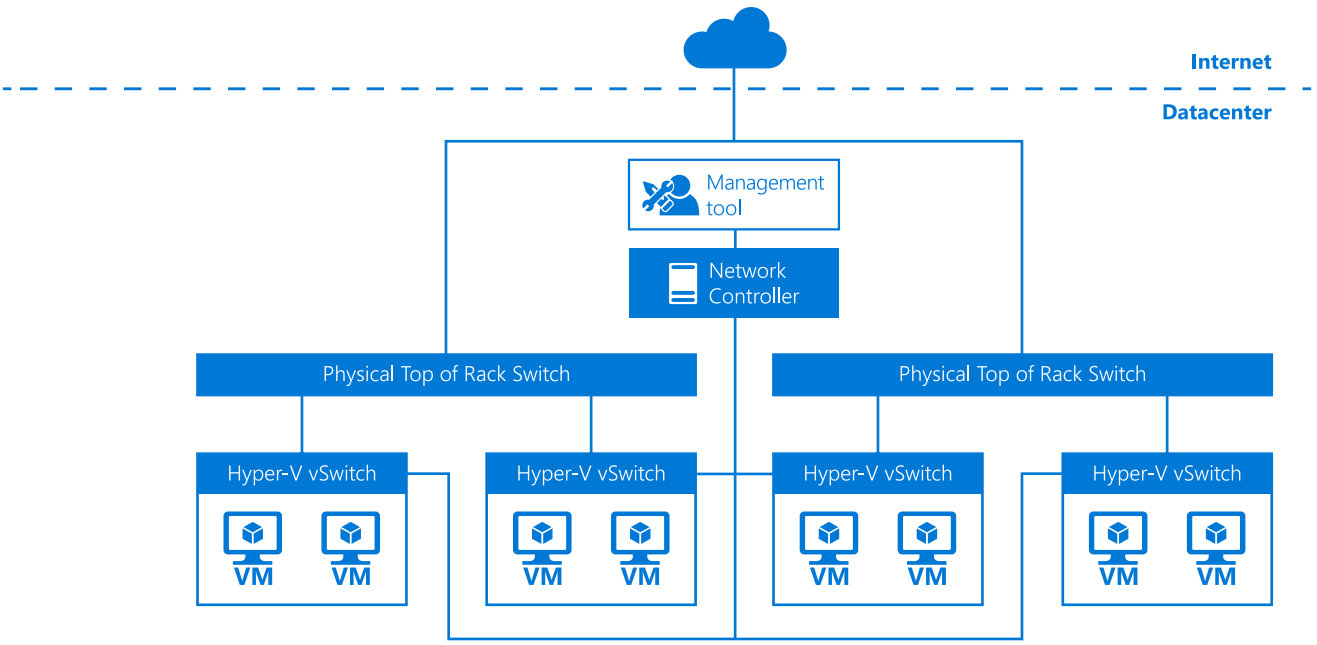

Figure 4: Administrators can use a management tool, such as PowerShell, RESTful API, or System Center Virtual Machine Manager to interact directly with Windows Server 2016 Network Controller, which provides information about the network infrastructure, including both virtual and physical infrastructure, and enables configuration changes based on administrator's actions.

One way to improve security in highly virtualized environments is to segment the network to allow VMs to talk only to the specific systems required for an operation. If an application doesn't need to connect with the Internet, for example, it can be isolated from that traffic. Windows Server 2016 includes a distributed firewall to support security policies that can help protect applications. Policies can be applied anywhere across the virtual network infrastructure, isolating VM to VM traffic, VM to host traffic, or VM to Internet traffic where necessary—either for individual systems that may have been compromised or programmatically across multiple subnets.

Management and automation

Microsoft System Center 2016. Whether an organization is managing a few servers or thousands, System Center provides efficient deployment and management functionality for a virtualized, software-defined datacenter to improve agility and performance.

PowerShell. IT teams can delegate time-consuming, everyday activities to automation, using PowerShell capabilities in Windows Server 2016. PowerShell enables IT admins to use one console to automate, deploy, configure, manage, and decommission applications, servers, settings, and users on one server or many. Using PowerShell's cmdlets, providers, modules, snap-ins, scripts, functions, and profiles, the updated Desired State Configuration environment can save time by defining the desired state and delivering automatic alerting and remediation if things go wrong on Linux or Windows. This automation helps IT admins offer infrastructure as a service to internal customers on a self-service basis and keep one step ahead of resource requests.

Server management tools. The cloud-based toolset includes a remote GUI to help manage Windows Server instances wherever they are, on physical or virtual machines in the datacenter, or in the cloud. Log onto Azure using a browser from any client, Windows, Mac OS, or Linux distribution, to manage Windows Server installations remotely.

Application platform: Develop apps faster and more securely

The cloud enables businesses to innovate quickly and deliver faster time to value with agile applications and microservices architectures. However, most businesses are grappling with how to manage and update thousands of existing applications running on earlier versions of Windows Server, while planning how to move to this new world. Organizations need a solution that helps invigorate and secure existing applications and build new agile applications that work on-premises, in a hybrid environment, or in the public cloud.

Windows Server 2016 supports application innovation using container technology and microservices. Containers can help speed application deployment and streamline the way IT operations and development teams collaborate to deliver applications. In addition, developers can use microservices architectures to separate app functionality into smaller, independently deployable services, which make it easier to upgrade part of the app without affecting the rest.

Windows Server 2016 provides organizations options by supporting applications three ways:

1. Enable existing apps to run in a more secure way.
2. Support the use of containers with existing apps.
3. Enable the creation of new hybrid or cloud apps using microservices architectures.

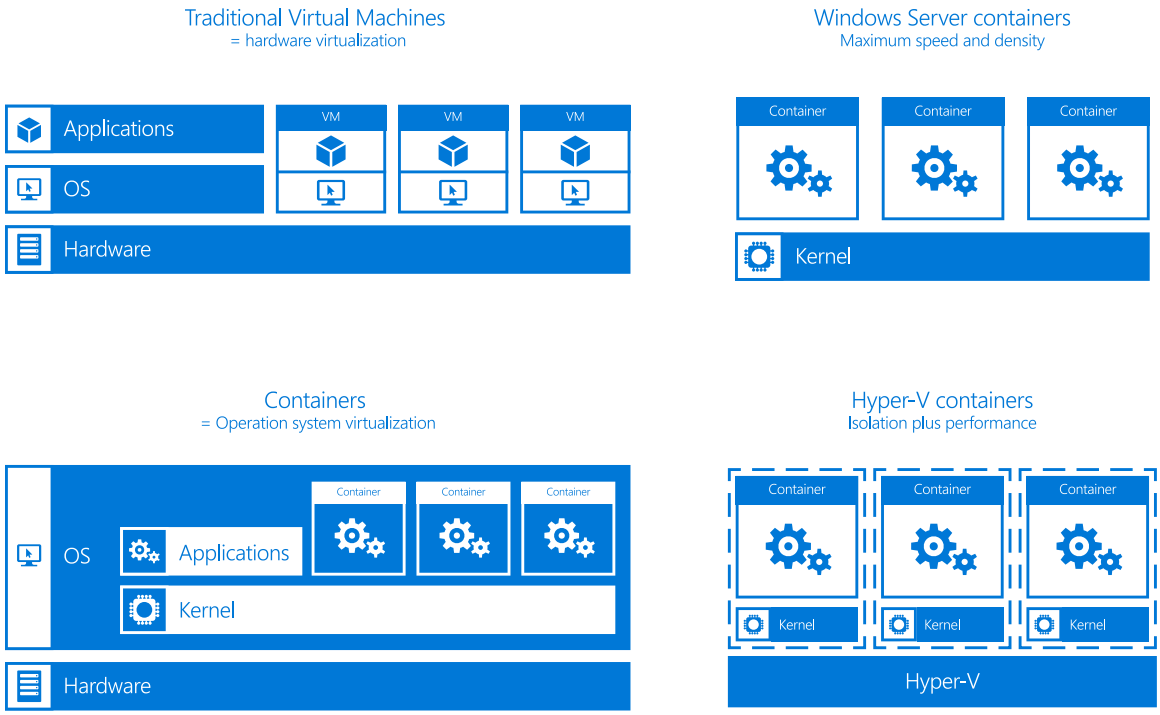

Figure 5: Server virtualization helped IT administrators move away from a 1:1 application-to-server ratio and deploy applications faster. Today, IT organizations are using containers to move even faster. Containers are an operating system-level isolation method for running multiple applications on a single control host. Unlike VMs, containers are not fully isolated, since containers share the host kernel with other containers. Windows Server containers achieve isolation through namespace and process isolation. Hyper-V containers add additional isolation by encapsulating each container in a lightweight virtual machine.

Secure fabric to protect virtual machines

Organizations can run existing apps with more security and efficiency using Windows Server 2016 by taking advantage of enhanced security and storage features in a definable fabric. Use Shielded Virtual Machines to secure critical applications to run only on trusted hosts. Limit administrator access to specific tasks with Just Enough Administration and specific time limits with Just-in-Time Administration.

Best friends—Windows Server and SQL Server

The most frequently deployed commercial database platform on Windows Server is SQL Server, which is a big reason why Microsoft continues to drive toward an unmatched price-to-performance ratio for this powerful technology combo.

In the previous production release, with SQL Server 2014 running on Windows Server 2012 R2, organizations can achieve $0.73 per QphH in decision support workloads.[1] For OLTP support workloads customers can reach $126.49 per tpsE.[2] Those figures represent industry leading performance and cost efficiency, made possible because of the Windows Server memory and CPU configuration maximums. For this benchmark, the maximum configuration possible was 4TB. In Windows Server 2016, the maximum configuration increases by 6 times to 24 TB, and IT organizations can run up to 640 CPU cores.

Gone are the days of scaling out a cluster to scale up performance

The Windows Server 2016 focus on Storage Class Memory, including non-volatile dual in-line memory module (NVDIMM) and NVMe, provides direct value to SQL Server. SQL Server 2016 performs better using Windows Server and NVDIMM in dealing with transaction logs as the database doesn't have to incur latency waiting for the disk system to flush to persistent storage—the DIMM itself has persistent storage capabilities.

Using Storage Class Memory also has the effect of decreasing CPU usage for the same size workload. With 12TB available to the data platform from the OS, system analytics will complete faster and can be more sophisticated. Before, applications had to manage complexity at the database tier with multiple queries and logic at the application level.

Gone are the days of scaling out a cluster to scale up performance. SQL Server deployments are able to reach "five nines" of availability, and in Windows Server 2016, customers can upgrade a server cluster with no downtime. The goal is to deliver simple, flexible high-availability and disaster recovery scenarios that deliver higher database uptime.

Security is a key focus as well. Digging into Common Vulnerability and Exploit (CVE) data and National Vulnerability Database (NVD) data from Mitre and the U.S. National Institute of Standards and Time, the last 10 years of data shows that the combination of Windows Server and SQL Server yields the lowest percentage of CVEs issued among common datacenter operating systems and database systems.[3,4] Maintaining a strong security posture for data requires that organizations consider both the underlying operating system and the database platform—if the operating system is vulnerable, so is the data.

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1 Benchmark established for TPC-H tests, lowest price/performance at 1,000 GB size, non-clustered. Full results available at http://www.tpc.org/tpch/results/tpch_price_perf_results.asp?resulttype=noncluster&version=2%&currencyID=1

2 Benchmark established for TPC-E tests. Full results available at http://www.tpc.org/tpce/results/tpce_price_perf_results.asp?resulttype=all&version=1&currencyID=0

3 Data acquired from https://web.nvd.nist.gov/view/vuln/search February 29, 2016.

4 Microsoft internal research excluding database products unavailable for the 10-year period.

Evolve existing apps with containers

IT organizations can use containers to move traditional applications into a modern environment with little or no code changes. Gain benefits such as consistency across dev, test, and production using the same tooling, which enables rapid deployments, continuous integration and continuous delivery, all with better security. Use containers to gain control and consistency by enabling "write-once, run-anywhere" apps that can be deployed on-premises, to any cloud, or in a hybrid architecture across clouds. For an additional layer of isolation, deploy the app in a Hyper-V container, which packages the same container image with its own dedicated kernel, ensuring tighter isolation in multi-tenant environments.

Build cloud-native and hybrid apps

Windows Server 2016 ships with agile technologies for building cloud-native applications and microservices architectures. Nano Server's "just enough OS" model enables organizations to build customized OS images that are highly optimized just for the application needs, providing a fast-booting, tiny OS that achieves higher density per server and a reduced attack surface. Developers can create apps with familiar tools, including third-party frameworks such as Node.js. Organizations can use proven Azure Service Fabric technology along with Windows Server 2016 to build always-on, scalable, and distributed applications and run them in Azure, on-premises, with a partner, or in a hybrid model. By combining the benefits of containers with Nano Server, Service Fabric and the proven Windows Server platform to build innovative cloud-native applications, organizations can better respond to market changes.

Linux and FreeBSD workloads

Microsoft has embraced Linux and FreeBSD as an important aspect of the company's strategy, both on-premises and in the Azure public cloud. With Hyper-V, Microsoft contributes code to the Linux kernel and supports a wide variety of Linux distributions—both commercial and community-driven—including Red Hat Enterprise Linux, SUSE Linux Enterprise Server, CentOS, Ubuntu, Debian, and Oracle Linux, as well as standard FreeBSD releases. Organizations can run Windows, Linux, and FreeBSD on a single set of Hyper-V hosts, driving up utilization and reducing hardware costs. They gain a single experience for managing, monitoring, and operating the infrastructure. Virtual appliances based on Linux and FreeBSD are available from a variety of partners to run on Hyper-V infrastructure.

In Windows Server 2016, almost all of the new software-defined infrastructure capabilities accrue to Linux and FreeBSD guests as well as Windows guests, including storage features, networking features, and PowerShell-based automation. New Hyper-V features in 2016, such as runtime memory resize and hot add/remove vNICs, enable customers to change Linux guest configuration with no downtime. Discrete Device Assignment (PCI-E pass-thru) is fully supported for Linux guests, enabling high-performance networking using SR-IOV or guest access to GPUs for high-performance computing (HPC) workloads. Linux guest performance on Hyper-V is fully on par with Windows guest performance, and fully on par with Linux guests on other hypervisors. In short, Linux and FreeBSD workloads run great on Hyper-V, right alongside Windows workloads.

Conclusion

IT decision-makers understand that technology continues to change. Every 20 years or so, a transformational shift in technology makes people rethink everyday activities. But change doesn't have to mean disruption. Microsoft's approach is to ensure that major transitions offer options that enable customers to take advantage of existing infrastructure and applications while evolving into the new mobile-first, cloud-first world.

Even organizations not yet ready to move to the cloud can benefit from cloud advances as Microsoft cross-fertilizes its technology innovation across Windows Server, Hyper-V, System Center, and Microsoft Azure. Only Microsoft delivers a broad spectrum of enterprise cloud platform options to help customers choose the right one to fit business needs. Windows Server 2016 is full of exciting innovation and the perfect next step for the server operating system foundation.

APPENDIX

Microsoft

Feature Comparison Summary

Windows Server 2016, Windows Server 2012 R2, and Windows Server 2008 R2

Windows Server 2016 – The cloud-ready operating system

Windows Server 2016 is the cloud-ready operating system that delivers new layers of security and Azure-inspired innovation for the applications and infrastructure that power your business. Increase security and reduce business risk with multiple layers of protection built into the operating system. Evolve your datacenter to save money and gain flexibility with software-defined datacenter technologies inspired by Microsoft Azure. Innovate faster with an application platform optimized for the applications you run today, as well as the cloud-native apps of tomorrow.

How to use this comparison guide

Use this guide to compare specific features of Windows Server versions to understand the differences between the version you are running today and the latest version available from Microsoft.

Security is a top priority for IT teams. New threats have made it harder than ever for IT to secure data and applications. Windows Server 2016 gives you new capabilities to help prevent attacks and detect suspicious activity, with features to control privileged access, help protect virtual machines, and harden the platform against emerging threats.

Scenario	Feature Description	Windows Server 2008 R2	Windows Server 2012 R2	Windows Server 2016
Security	Shielded Virtual Machines: Uses BitLocker to encrypt disk and state of virtual machines.	○	○	●
	Host Guardian Service: Helps ensure Hyper-V hosts running Shielded Virtual Machines are allowed and healthy hosts.	○	○	●
	Just Enough Administration (JEA): Limits administrative privileges to the bare-minimum required set of actions (limited in space).	●	●	●
	Just-in-Time Administration (JIT): Provides privileged access through a workflow that is audited and limited in time.	◑	●	●
	Credential Guard: Uses virtualization-based security to help secure credential information.	○	○	●
	Remote Credential Guard: Works in conjunction with Credential Guard for Remote Desktop Protocol (RDP) sessions to deliver Single Sign On (SSO), eliminating the need to pass credentials to the RDP host.	○	○	●
	Device Guard: Helps ensure only authorized executables run on the machine.	○	○	●
	AppLocker: Provides policy-based access control management for applications.	◑	●	●
	Windows Defender: Automatically helps protect machines from malware while allowing legitimate applications to run.	◑	◑	●
	Control Flow Guard: Protects against unknown vulnerabilities by helping prevent memory corruption attacks.	○	○	●
	Generation 2 virtual machines: Allows VMs to use hardware-based security to leverage Secure Boot, BitLocker, etc.	○	◑	●
	Enhanced auditing for threat detection: Provides better log information.	○	◑	●
	Dynamic Access Control: Enables administrators to apply access-control permissions and restrictions based on well-defined rules.	○	●	●
	Windows Firewall with Advanced Security: Allows granular firewall configuration.	○	●	●
	BitLocker: Uses a hardware or virtual Trusted Platform Module (TPM) chip to provide disk encryption for data and system volumes.	◑	●	●
	Small-footprint Hyper-V host (Server Core/Nano Server): Minimizes attack surface with a Hyper-V host running minimum required components.	◑	◑	●

○ Not Supported ◑ Limited Support ● Fully Supported

Datacenter operations seem to earn more scrutiny than budget these days. New applications stretch the operational fabric and create infrastructure backlogs that can slow business. IT organizations are expected to do more with less, but an aging infrastructure with little automation becomes a hindrance to moving forward. As organizations look beyond server virtualization for more efficiency, they can use Windows Server 2016 capabilities to meet operational and security challenges, freeing up IT resources to plan and innovate on future solutions that drive business success.

Scenario	Feature Description	Windows Server 2008 R2	Windows Server 2012 R2	Windows Server 2016
Software-defined compute	Cluster OS Rolling Upgrade: Enables you to upgrade your server clusters from Windows Server 2012 R2 to Windows Server 2016 while continuing to provide service to your users.	○	○	●
	Linux and FreeBSD Workloads: Enables most of the Windows Server software-defined datacenter features for Linux and FreeBSD guests running on Hyper-V for increased functionality, performance, and manageability.	◑	◑	●
	Hot add and remove for disk, memory and network: Add or remove a network adapter and adjust the amount of memory assigned while the VM is running, without any interruption. The memory adjustment capability works even when you have Dynamic Memory turned on for a Hyper-V host.	○	◑	●
	Mixed OS Mode cluster: Provides ability for Windows Server 2012 R2 cluster nodes to operate with Windows Server 2016 nodes.	○	◑	●
Software-defined storage	Storage Spaces Direct: Enables industry standard servers with local storage to build highly available and scalable software defined storage.	○	○	●
	Storage Replica: Provides storage agnostic, block-level, synchronous replication between servers for disaster recovery, and allows stretching of a failover cluster for high availability.	○	○	●
	Site-Aware Failover Clusters: Enables nodes in stretched clusters to be grouped based on physical location, enhancing key cluster-lifecycle operations, such as failover behavior, placement policies, heartbeating between nodes, and quorum behavior.	○	○	●
	Storage Quality of Service (QoS): Uses policies to define and monitor storage I/O minimums and maximums for virtual machines to enable consistent performance across VMs.	○	◑	●
	Data deduplication: Provides volume savings of up to 90% by storing duplicate files on a volume once using logical pointers.	○	◑	●
	Virtual machine storage resiliency: Provides intelligent means to retain virtual-machine session states to minimize the impact of minor storage disruptions.	○	○	●

○ Not Supported ◑ Limited Support ● Fully Supported

Scenario	Feature Description	Windows Server 2008 R2	Windows Server 2012 R2	Windows Server 2016
Software-defined storage, continued	Storage health monitoring: Provides continuous monitoring, reporting, and maintenance to support Storage Spaces Direct.	○	○	●
Software-defined networking	Network Controller: Provides a centralized, programmable point of automation to manage, configure, monitor, and troubleshoot virtualized network infrastructure in your datacenter.	○	○	●
	Virtual networking: Helps create network overlays on top of a shared multi-tenant physical fabric.	○	●	●
	Software Load Balancer (SLB): A cloud-optimized Layer 3 and Layer 4 load balancer that provides both North–South and East–West load balancing.	○	○	●
	Distributed firewall and microsegmentation: Dynamically segment networks based on evolving security or application needs using a stateful firewall and network security groups.	○	◑	●
	Hybrid SDN gateways: Multi-tenanted, highly available gateways that connect customer virtual networks to Azure, other Windows Server-powered clouds, high-speed WANs, and local non-virtualized resources.	○	●	●
	Converged RDMA: Converge RDMA storage traffic and tenant Ethernet traffic on the same underlying NIC team for significant cost savings, while getting the desired throughput and quality of service.	○	○	●
	IP Address Management (IPAM) and DNS: IPAM now supports comprehensive DNS and DHCP management with role-based access control across multiple AD forests. DNS provides for traffic management, load balancing, and split-brain deployments and prevention of DNS amplification attacks.	○	◑	●
Other Capabilities	PowerShell 5.1: Provides enhanced scripting capabilities for configuration, management, and deployment of software-defined datacenter components.	●	●	●
	MultiPoint Services Role: New role in Windows Server 2016 that enables low cost-per-seat by allowing multiple users to run their own sessions while connected to one machine.	○	○	●
	RDS RemoteFX vGPU: Provides a rich desktop remoting experience (up to 4k) by allowing multiple VMs to share the same physical GPU for graphics acceleration.	○	◑	●
	High-availability RDS Connection Broker: Helps create a fault-tolerance connection broker for Remote Desktop scenarios.	○	◑	●
	RDS VM architecture for cloud: Windows Server 2016 can leverage Azure services for more cost effective solutions. (Application Proxy, AD Domain Services).	○	○	●
	Server management tools: Allows remote server management of on-premises servers using Azure capabilities.	◑	◑	●
	Nano Server installation option: New remote-administered option for private clouds and datacenters.	○	○	●

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Support developers in the race to create cloud-ready, business-changing apps and services, whether on-premises or in any cloud, using technologies such as containers and the lightweight Nano Server installation option. Windows Server 2016 can help you modernize your apps and innovate faster.

Scenario	Feature Description	Windows Server 2008/R2	Windows Server 2012/R2	Windows Server 2016
Cloud-Ready Application Platform	Windows Server containers: Creates an isolated application environment (kernel, system drivers, etc.), in which you can run an application without fear of changes due to applications or configuration.	○	○	●
	Hyper-V containers: Provides a highly isolated environment in which to operate, where the host operating system cannot be affected in any way by any other running container.	○	○	●
	Nano Server installation option: New, lightweight option for Windows Server 2016, optimized for cloud infrastructure and perfect for running microservices and applications in containers.	○	○	●
	PowerShell 5.1: Provides enhanced scripting capabilities for configuration, management and deployment of software-defined datacenter components.	●	●	●
	PowerShell Desired State Configuration (DSC): Provides a set of PowerShell language extensions and cmdlets to declaratively specify how you want your software environment to be configured.	●	●	●
	Azure Service Fabric for Windows Server: Enables you to create a multi-machine Azure Service Fabric cluster in your own datacenter or in other public clouds.	●	●	●
	Visual Studio Code: Supports development operations such as debugging, task running and version control to provide just the tools a developer needs for a quick code-build-debug cycle.	●	●	●
	.NET Core: Helps create modern web apps, microservices, libraries and console applications that run on Windows, Mac, and Linux.	●	●	●

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