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New VMware vSphere 6 Features

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Introduction

VMware takes another step forward, building on previous vSphere generations, toward fully enabling the Software-Defined Data Center (SDDC). VMware vSphere 6 brings tighter integration between products, much needed improvements to several core features, as well as the bundling of backup and recovery functions. This white paper will provide a look at many of the new features but does not exhaustively cover every change.

We will discuss the following changes, enhancements, and new features:

- vSphere platform (to include virtual machine [VM] and ESXi maximums, vCenter Server architectural changes and scalability)
- vSphere High Availability (HA)
- vSphere Fault Tolerance (FT)
- vSphere vMotion
- Virtual Volumes
- NFSv4.1
- Network I/O Control
- Content Library

Licensing Overview

As with any major VMware release, the vSphere licensing scheme has been updated to include the new vSphere 6.0 features and functionality.

vSphere 6.0 has three license editions available with Operations Management:

- **Standard Edition**—contains the hypervisor and 1 vCenter Server Standard license, VMware vRealize Operations Standard, vMotion, Cross vSwitch vMotion, Storage vMotion, vSphere HA, vSphere Data Protection and vSphere Replication, Fault Tolerance (up to 2 vCPUs), vShield Endpoint, Virtual Volumes (as well as vSphere APIs for Storage Awareness), and Content Library
- **Enterprise Edition**—same as the Standard Edition, plus it includes APIs for Array Integration and Multipathing, Distributed Resources Scheduler (DRS) and Distributed Power Management (DPM), and Big Data Extensions
- **Enterprise Plus Edition**—includes aforementioned features plus the addition of Fault Tolerance (up to 4-vCPU), Distributed Switch, Storage DRS, Network and Storage I/O Controls, Host Profiles and Auto Deploy, Flash Read Cache, and Cross vCenter and Long Distance vMotion

There are also two vSphere Essentials kits available to purchase. The Essentials license contains one vCenter Server Essentials license and hypervisor licensing. Essentials Plus consists of one vCenter Server Essentials license, hypervisor licensing, vMotion and Cross vSwitch vMotion, vSphere HA, Data Protection, Replication, and vShield Endpoint.

See https://www.vmware.com/products/vsphere/pricing or more information on vSphere licensing.

New Features

This section of the white paper will provide an overview of the most anticipated new features or changes in vSphere 6. It is not meant to be an all-inclusive list of the changes and features introduced in the new release.

Bigger Everything!

The maximums associated with ESXi hosts have increased once again . . . the maximums were already large and now they are huge! The amount of ESXi hosts in the cluster doubles as well. Note that the host maximums do not align with the cluster maximums. 64 ESXi hosts x 1,000 VMs = 64,000 VMs but the cluster maximum is 8,000. This maximum stems from vCenter Server and not an ESXi limitation.

The following table provides an overview of the changes in the ESXi host maximums between vSphere 5.5 and vSphere 6.

vSphere 5.5	vSphere 6.0
512 VMs per host	1,000 VMs per host
320 CPUs	480 CPUs
4 TB RAM	12 TB RAM
32 hosts per cluster	64 hosts per cluster
4,000 VMs per cluster	8,000 VMs per cluster

ESXi hosts aren't the only thing to see an increase in maximums—VMs have also seen some increases. vSphere 6 introduced VM hardware version 11, bringing a handful of changes.

The following list provides some of the most useful enhancements:
- up to 128 vCPUs per VM
- up to 4 TB RAM per VM
- up to 32 serial ports per VM
- hot-add memory is NUMA aware
- removal of serial and parallel ports
- WDDM 1.1 GDI acceleration
- USB 3.0 xHCI

Prior to vSphere 6, hot adding memory to memory would result in new memory being allocated to NUMA node 0. Now memory is allocated equally across all NUMA regions.

vCenter Server Architectural Enhancements

The architecture for vCenter Server has changed with 6.0; there are now two main installable components: the new Platform Services Controller (PSC) and the vCenter Server system and their respective services.

The PSC includes the following services:
- VMware vCenter Single Sign On
- VMware Directory Services
- VMware License Server
- Lookup Service
- Certificate Authority
- Certificate Store

The group of vCenter Server services contains the following:
- vCenter Server
- vSphere Web Client
- VMware Inventory Service
- vSphere Auto Deploy
- ESXi Dump Collector
- vSphere Syslog Collector

There are two deployment models for vCenter Server 6.0, embedded and external. An embedded deployment co-installs the two components on the same machine, whereas an external deployment results in the PSC and vCenter Server on separate machines. The group of services associated with the two installable components will be installed; there are no longer installers for each of the services. The exception to this is vSphere Update Manager, which is installed as a standalone Windows installation.

Both the Windows vCenter Server and the vCenter Server Appliance support the use of an embedded PostgreSQL database. The Windows vCenter Server also supports Microsoft SQL and Oracle, whereas the vCenter Server Appliance supports just Oracle.

	Window vCenter Server	vCenter Server Appliance
Hosts per vCenter	1,000*	1,000
Powered on VMs per vCenter	10,000*	10,000
Hosts per cluster	64	64
VMs per cluster	8,000	8,000
Database Options	Oracle, SQL, or embedded	Oracle or embedded
Linked Mode	Yes	Yes
IPv6 Support	Yes	Yes

*These numbers assume the use of Oracle or SQL with the Windows vCenter Server. The scalability of the PostgreSQL database with the Windows vCenter Server (6.0) is currently 20 hosts and 200 VMs.

Linked mode is now automatically enabled with any vCenter Server deployment; PSCs replicate all the information that linked mode traditionally required. As long as the vCenter Server instances are joined to the same vCenter Single Sign On domain, the vCenter Server instances are linked, regardless of whether a Windows install or vCenter Server Appliance. No further configuration steps are needed.

Certificate management has also changed with this vSphere release. The PSC contains a component known as the VMware Certificate Authority (VMCA), which is a root certificate authority (CA) that issues signed certificates to the vSphere 6.0 components. The VMCA may also be configured as a subordinate CA, allowing it to issue certificates based upon an existing enterprise CA. Also included with the PSC is the VMware Endpoint Certificate Store (VECS). The VECS is a local repository for private keys and certificates and is a mandatory component regardless of whether you use the VMCA to sign your certificates. Don't forget that ESXi certificates are stored on the ESXi host and not within the VECS.

With the many architectural changes in vSphere 6.0, there is a great deal of information to consider while planning for a new deployment or upgrade!

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Fault Tolerance Enhancements

vSphere FT provides continuous VM availability in the event of failure by creating a live, secondary instance of the VM that is kept up to date with the primary VM. Should a failure occur, vSphere FT automatically fails over to the VM with zero data loss.

The following table outlines changes between vSphere 6.0 FT and the previous version.

	vSphere 5.5 FT	vSphere 6.0 FT
FT Technology	Record-Replay	Fast Checkpointing
vCPUs	1 vCPU	4 vCPU
Memory	64 GB	64 GB
Virtual Disk Type	Eager Zeroed Thick	Eager and Lazy Zeroed Thick, Thin
Backup	No	Yes
Storage Redundancy	No (shared VMDK files)	Yes (separate VMDK files)
Paravirtual Device Support	No	Yes
HA Support	Yes	Yes
DRS Support	Partial	Partial (initial placement)
DPM Support	Yes	Yes
SRM Support	Yes	Yes
Max FT VMs per host	4 FT protected VMs	4 FT protected VMs or 8 FT protected vCPUs
FT Network	1 Gbps	10 Gbps

Due to a completely new technology being used for vSphere 6.0 FT, VMs with up to four vCPUs can be supported. The VMware vSphere Storage APIs–Data Protection (VADP) may also be used with VMs protected by vSphere FT. Now administrators using VMware snapshot-based backup utilities are able to further protect their vSphere FT VMs. Another overdue enhancement is in how vSphere FT handles storage; rather than having a single copy of the VM files on the datastore shared by both the primary and secondary VMs, vSphere FT creates a complete copy of the entire VM and places it on a separate shared datastore.

With the new FT enhancements, more business-critical VMs can be configured with this feature in order to accomplish zero downtime.

High-Availability Enhancements

vSphere High Availability (HA) is a cluster feature that monitors ESXi hosts and VMs to detect hardware and guest OS failures and restart VMs onto other ESXi hosts when failure is detected. Prior to vSphere 6.0, vSphere HA was unable to detect All Paths Down (APD) conditions and had very limited ability to detect Permanent Device Loss (PDL) conditions. With the new release, vSphere HA includes Virtual Machine Component Protection (VMCP) that provides protection against APD and PDL conditions for shared Virtual Machine File System (VMFS) and network file system (NFS) datastores.

A PDL occurs when a storage array issues a Small Computer System Interface (SCSI) Sense Code that indicates the device is unavailable. When a PDL state is detected, the ESXi host stops sending I/O requests to the storage array since the device is considered to be permanently unavailable.

If an ESXi host cannot access a storage device but there is no PDL SCSI code being returned from the storage array, then the storage device is considered to be in an APD state. This state differs from a PDL because the ESXi host does not have enough information to determine whether the loss is permanent or temporary. The ESXi host will continue to retry I/O commands to the storage device until a threshold, known as the APD timeout, of 140 seconds (by default) has been reached. At this time, the ESXi host will begin to fast fail any I/O to the storage device.

With vSphere 6.0 HA, in the event of a PDL, a VM will be instantly restarted onto a host in the cluster with storage connectivity. Once an APD is declared (by default 140 seconds after initially detected), a HA timer of three minutes will begin. Once three minutes elapse, the HA can restart the VMs. However, Virtual Machine Component Protection (VMCP) can be configured to respond differently.

vMotion Enhancements

vSphere vMotion capabilities have been improved in the new release, allowing live migration of VMs across virtual switches, across vCenter Servers, and across long distances (up to 150ms RTT).

The ability to live migrate a VM across different vCenter Servers and across long distances changes the way we think about designing vSphere architectures and geographic limitations. This functionality will come in handy when migrating workloads to a different location for "follow the sun" support, disaster avoidance, load balancing across physical sites, and so on. There are a few requirements for Cross vCenter Server vMotion:

- Source and destination vCenter Server must be running version 6.0 or greater.
- Source and destination vCenter Server need to be joined to the same SSO domain using enhanced linked mode if the GUI will be used.
- There needs to be at least 250 Mbps of available network bandwidth per vMotion operation.
- Enterprise Plus licensing is required for Cross vCenter Server and Long Distance vMotion.
- This is not a requirement, but Layer 2 connectivity is needed on the source and destination port groups. The IP address within the guest OS in the VM will not change.

Whenever a VM is migrated across vCenter Servers, the settings for the VM are preserved. These settings include the universally unique identifier (UUID), resource settings (shares, limits, reservations), HA and DRS settings, alarms, event and task history, and MAC address. The MAC address is added to an internal blacklist to ensure that a duplicate MAC is not generated once a VM is moved out of the vCenter Server.

Storage Enhancements

Virtual Volumes transform the way storage is managed, enabling array-based operations at a virtual disk level. It provides a common storage platform that is independent of the underlying hardware, effectively introducing a storage abstraction layer. The Virtual Volumes services are the same no matter what the underlying physical resources are. Administrators will use Storage Policy-Based Management (SPBM) to create policies ensuring that the VMs are running on the correct storage. If a VM is not, then it will be shown as non-compliant to its storage policy, and remedial action may be taken. Historically, VMs are deployed to a logical unit number (LUN) or volume and all VMs on that LUN or volume shared the performance of that storage device. With Virtual Volumes, management is shifting away from the traditional LUN-centric approach and shifting management to the virtual machine disk (VMDK). Making the VMDKs the first-class citizens in the storage world eliminates many of the scalability, size, and quality of service (QoS) limitations of a traditional LUN management.

Virtual Volumes introduces the abstraction of pooling of storage by presenting a "storage container" to the ESXi hosts. This storage container is an aggregate or group of disks, but with Virtual Volume extensions. Once this storage container is made visible to the ESXi hosts, a Virtual Volume datastore is created from it in a similar

fashion as creating a VMFS datastore. The array storage is now visible to the ESXi host, albeit in an abstracted/pooled manner. The use of vSphere APIs for Storage Awareness (VASA) is required in order to offload the data services to the array.

VMware introduced NFSv4.1 support with vSphere 6.0. This support provides a handful of great improvements and new features, to include:
- Kerberos authentication
- Server-side locking
- Session trunking (not Parallel NFS, pNFS is not supported)
- Improved error recovery

There are a few things to be aware of. First, NFS v4.1 datastores have interoperability with vMotion, HA, FT, and DRS, but no support for SDRS, SIOC, SRM, or Virtual Volumes as of yet. Another consideration is that an NFS volume should not be mounted as NFS v3 to one ESXi host, and NFS v4.1 to another ESXi host. A best practice would be to configure any NFS/NAS array to only allow one NFS protocol access, either NFS v3 or v4.1, but not both. NFS v3 uses propriety client side co-operative locking. NFS v4.1 uses server-side locking.

Networking Enhancements

vSphere Network I/O Control has been updated to Version 3, allowing a bandwidth guarantee (reservation) not only at a distributed port group, but also at a Virtual Network Interface Card (vNIC) level in a VM. This flexibility ensures that VMs don't impact other VMs when sharing the same upstream links or bandwidth.

Content Library

The new Content Library simplifies the management and distribution of VM templates for organizations with vCenter Servers across multiple geographic locations. VM templates, ISO images, scripts, etc. can be centrally managed and published; other sites are able to subscribe to the catalog in order to access its contents. As the library content is updated, the subscribers will automatically receive the distributed changes. This functionality ensures that all sites have access to the standardized library contents without having to manually distribute VM templates.

Conclusion

With the release of vSphere 6.0, the big changes revolve around expanded resource limitations, enhanced vMotion capabilities, changes in the vCenter Server architecture, availability, and more. Content Library and other cross-site features improve the idea of the SDDC. These advances keep VMware holding the leadership role in server virtualization.

References

For more information on VMware vSphere 6.0 and the features mentioned in this paper, see the following documents on VMware's website:

- [VMware vSphere 6 Datasheet](#)
- [What's New in the VMware vSphere 6.0 Platform](#)
- [VMware vSphere with Operations Management and VMware Sphere Licensing, Pricing and Packaging](#)
- [VMware vCenter Server Availability Guide](#)
- [VMware vSphere Networking Guide](#)
- [VMware vSphere Storage Guide](#)

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About the Author

Rebecca Fitzhugh is a VMware Certified Instructor and consultant whose primary focus is on VMware virtual infrastructure products as well as the vCloud and Horizon suites. Prior to becoming an instructor and consultant, Rebecca served five years in the United States Marine Corps where she assisted in the build-out and administration of multiple enterprise networks residing on virtual infrastructure. Packt Publishing recently published her book, *vSphere Virtual Machine Management*.