5.3.6 Storage Pool Facts

Storage spaces are logical drives for storing data and other user files. Storage spaces are created from *storage pools*, a collection of space from multiple disk drives or other storage devices. A storage space displays and is managed as a single drive regardless of the number of disks or devices contributing space to the storage pool.

Storage spaces are composed of three components:

- *Devices* are the hard disks or other types of storage from which storage pools are created. You can use a variety of devices to create storage pools, such as SAS drives, SATA drives, SCSI drives, and even external USB drives.
- *Pools* of storage are created from the available disk space. A pool is composed of the free space available on the specified storage devices.
- *Storage spaces* define virtual disks created from available disk space in a pool. One or more storage spaces can be created from a single pool. To the Windows system and the user, a storage space appears as a single disk with typical drive letters assigned.

Storage spaces can be managed dynamically, and they eliminate the need for tasks like repartitioning drives, resizing volumes, and backing up data in order to repartition. When you need more disk space for your storage spaces, follow these steps:

- Install a new storage device to the system.
- Add unallocated space on the device to a storage pool.
- Allocate space to an existing storage space.

A disk must be online and unallocated (not formatted or partitioned) to be added to a storage pool.

The following table identifies configuration options in storage pool creation:

Option	Description
Allocation	Each disk in the pool is allocated as automatic or as a *hot spare*. ▪ Space allocated as automatic becomes available in the storage pool. ▪ Space allocated as a hot spare is reserved for use in the event that a disk in the pool fails.

Storage Layout	Storage spaces can include data resiliency implemented through storage layout options. When you create a virtual disk, choose a storage layout option. The options include:
	▪ *Simple*, which does not provide redundancy.
	  ▪ This option simply adds space from the storage pool to the storage space.
	  ▪ When you select the **Simple** option, all of the data in the storage space is lost if one of the drives fails.
	  ▪ This option is similar to RAID 0 (data striping).
	▪ *Mirror* requires at least two storage devices in the pool.
	  ▪ In *two-way mirroring*, the data is written to two devices.
	  ▪ Two-way mirror requires twice as much device space as the amount of storage allocated to the storage space.
	  ▪ This option protects you from a single storage device failure.
	  ▪ This option is similar to RAID 1 (mirroring).
	  ▪ In three-way mirroring, the data is written to three storage devices.
	  ▪ This option requires at least five storage devices in the pool.
	  ▪ This option provides redundancy for the data if two storage devices fail at one time.
	▪ *Parity* requires that you have at least three storage devices.
	  ▪ This option uses parity information to reconstruct data if one of the storage devices fails.
	  ▪ Parity uses less space for redundancy than the mirror options, but performance is not as good as the mirror options if a device failure occurs.
	  ▪ Parity requires only 50 percent more redundancy space than storage space.
	  ▪ This option is similar to RAID 5 (parity striping).
	All storage layouts except simple use more free space than their specified size.

Provisioning	*Fixed provisioning* allows you to specify the size of the space based on actual disk size. You can use all of the space on a disk or part of the space on a disk. *Thin provisioning* or *overbooking* allows you to allocate larger storage spaces than there is disk space available in the pool. ▪ Thin provisioning is based on the premise that not all users will use all of the space in their allocated storage space. ▪ Space is added to a user's storage space as the user consumes space. ▪ If a storage space runs out of disk space, it will immediately unmount, leaving any I/O processes vulnerable to data corruption.

	▪ An unmounted storage space must be brought back online manually. ▪ Files can be accessed after the storage space is brought back online manually, but you must add more physical disk space to the pool and add it to the storage space in order to use the storage space. Windows creates the virtual disk only if there is sufficient free space.
Storage Tiers	Storage tiers allow you to combine solid-state drives (SSDs) with traditional hard disk drives (HDDs) in a storage space. SSDs are typically much faster than HDDs, but are also considerably more expensive. HDDs are typically much larger and less expensive, but are also considerably slower than SSDs. Based on file usage, storage spaces automatically determine the type of drive on which the data is stored. When using storage tiers, storage spaces: ▪ Store frequently accessed data in the faster SSD tier for quick access. ▪ Store less-frequently accessed data in the less expensive but slower HDD tier. ▪ Analyze file usage on a specified schedule to assign data to each tier. ▪ Allow administrators to assign, or pin, a file to a specific tier, even though it may not meet the usage criteria for that tier. Storage tiers require fixed provisioning.
Write-back Cache	Storage spaces can leverage solid-state drives within a storage pool to create a write-back cache. This cache performs two key functions: ▪ It protects against data loss in the event of a power failure. ▪ It buffers small, random writes to solid-state drives that are very fast, but have less capacity. The cached data is then written to slower, high-capacity traditional hard disk drives at a later time, when disk utilization is low. Latency within the storage pool can be significantly reduced when using a write-back cache. If a storage pool contains enough physical SSD disks, GB write-back cache is enabled by default when a new storage space is created. To use write-back caching, the storage pool must meet the following requirements: ▪ A simple storage space must have at least one SSD drive. ▪ A two-way mirror storage space must have at least two SSD drives. ▪ A three-way mirror storage space must have at least three SSD drives. If there aren't enough SSD disks in the pool, then the write-back cache size is automatically set to **0**. This effectively disables write-back caching on the pool. Write-back caching is compatible with storage tiers. However, be aware that when the write-back cache is enabled in a storage space that uses storage tiers, the fast storage tier will actually be 1 GB smaller than the size you configure because of the SSD space allocated to the write-back cache.

Keep in mind the following about storage spaces:

- The *primordial* storage pool contains unallocated disks that are connected to the server but are not assigned to a storage pool.
- Once a storage space is created, you create one or more volumes on the drive and manage the disk as you would a physical disk.
- Use the **Detach Virtual Disk** option to detach the storage space before deleting it.
- The automatic rebuild feature automatically rebuilds storages spaces from storage pool free space in the event of drive failure. Automatic rebuild eliminates the need for hot spares in storage pools as long as there is a sufficient number of drives assigned to the pool.

Limitations of storage pools include:

- Disks containing the boot volume, system partition, or any Cluster Shared Volumes (CSV) cannot be added to the pool.
- The individual drives in the pool must be at least 10 GB.
- A storage pool must have at least one drive.
- Storage pools that use Fibre Channel and iSCSI are not supported for failover clusters.

PowerShell commands you can use to manage storage spaces include:

- **New-StoragePool** creates a new storage pool.
- **Add-PhysicalDisk** adds a new disk to an existing storage pool.
- **New-VirtualDisk** creates a virtual disk in the storage pool.
- **Get-StoragePool** retrieves information about the storage pool.

Enclosure awareness provides an added level of fault tolerance in which each copy of data is associated with a particular JBOD (just a bunch of disks) enclosure. If one of the disks fails, another copy of the data exists on one or more enclosures. Be aware of the following regarding

disk enclosures:

- Enclosure awareness mirrors data between two or more enclosures.
- Storage enclosures must support SCSI Enclosure Services (SES).
- Using multiple SAS adapters per enclosure and per server allows multipathing.
- The **-EnclosureAwareDefault** parameter of the **New-StoragePool** cmdlet identifies the default allocation policy for virtual disks created in an enclosure-aware storage pool.
- Cluster Shared Volumes I/O redirection is supported on enclosure-aware disks. This function mitigates data loss when the connection to the disk enclosures is lost, but the server maintains connection to the network.
- The following table identifies storage requirements:

Failed Enclosures	Configuration	Storage Required
1	Two-way mirroring	Three compatible storage enclosures
2	Three-way mirroring	Five compatible storage enclosures
1	Dual parity	Four compatible storage enclosures
