Abstract

One way to avoid the risk of data loss is to set up a RAID configuration. In Windows Server® 2012, you can set up disk mirroring (RAID1) for the operating system volume using tools included in Windows Server. Such a disk mirror does not prevent corruption or other errors, so you should also back up data regularly. This document details the steps to follow to set up the operating system volume mirror for both BIOS-based and UEFI-based systems.
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Configuring Disk Mirroring

One of the most common methods of avoiding and recovering from data-threatening disasters is to increase a system’s fault tolerance by using a RAID (redundant array of independent disks) configuration. Such configurations employ multiple hard disks in various arrangements to either duplicate data or distribute it over the disks (or both). Many different RAID configurations are possible, each offering different advantages and disadvantages depending on your particular goals and scenarios. Two or more disks can be configured as a RAID array using either software or hardware approaches. For more information about RAID in general, see [http://go.microsoft.com/fwlink/?LinkId=184841](http://go.microsoft.com/fwlink/?LinkId=184841).

In Windows Server® 2012, as long as you have one additional hard disk, you can set up mirroring (RAID1) for the operating system volume using only tools already built into the operating system. No special software or hardware is required. Once you set up the disk mirror, the operating system and your data will be present on both boot disks, and the system software will keep data and changes to the operating system (such as registry updates) in sync on both boot disks. If the primary boot disk should fail, the computer can switch over and boot from the secondary boot disk.

Be aware, however, that RAID configurations, including mirrored disks, do not prevent file corruption or other errors. You should still maintain a plan for backing up data regularly.

This document explains step-by-step how to set up a mirror of the operating system volume using BCDedit and Diskpart. It also explains how to reset the system to use a single, unmirrored boot disk, such as during the period until you can replace a failed disk. Separate procedures are provided for BIOS- and UEFI-based systems. For more information about the differences between BIOS and UEFI systems, see [http://go.microsoft.com/fwlink/?LinkId=184842](http://go.microsoft.com/fwlink/?LinkId=184842).

Considerations prior to creating the disk mirror

Before you set up the disk mirror, there are some important factors and limitations to keep in mind. Once you have set up the disk mirror, certain features behave differently and you may need to adjust your policies accordingly.
Updates
Windows does not automatically service the contents of the secondary system partition. If you install any operating system updates or service packs, be sure to manually update the secondary system partition (the mirror) with the same updates. To do this, be sure to follow Step 3 of the “Clone the system partition” procedure, where you use the Robocopy.exe command to copy the contents of the primary system partition to the secondary system partition.

Windows Server Backup
These considerations for Windows Server Backup apply only to the bare metal recovery backup and restore functionality. Other backup methods, such as file or folder backup and system state backup are not affected.

Windows Server Backup automatically selects critical volumes on the primary disk for backup, but not on the secondary disk. Be sure to configure Windows Server Backup to also select the relevant volumes on the secondary disk. For more information about critical volumes and Windows Server Backup in general, see http://go.microsoft.com/fwlink/?LinkID=184843.

If you have used Windows Server Backup to back up either disk in the mirror and if one of those disks fails, you will not be able to recover either disk from a backup until both disks are present again. Even though this document provides steps to reconfigure the system to work with one disk temporarily (see Reconfiguring the mirror after a disk failure), recovery using Windows Server Backup will not be possible until you have replaced the failed disk.

When the operating system volume is mirrored, Windows Server Backup does not mark the restored secondary system volume as active by default. In the event that you recover the secondary disk from a backup, you must manually set the secondary system partition as active.

In UEFI-based systems, the system volume on the secondary disk cannot be backed up with Windows Server Backup. In the event that you recover the secondary disk from a backup, the only way to recreate the system volume is to follow the “Clone the system partition from the primary disk to the secondary disk” procedure in the Creating a mirrored volume section.

Hibernation
The considerations for hibernation of Windows 8 and Windows Server 2012 machines apply to BIOS, as well as UEFI systems.

Hibernation, after the failure of a mirrored boot volume, may fail and should be disabled. The setup steps described in this document, as well as the
deployment scripts, do not provision for the use of hibernation of systems on which mirrored boot volumes are deployed.

Hibernation can easily be disabled with the following steps. In an ordinary, elevated command prompt type:

- `powercfg.exe /h off`

## Combination with Storage Spaces

Unused capacity on mirrored dynamic volumes can be used with Storage Spaces if the computer uses an UEFI instead of a BIOS. The last section of this document describes how to form a storage pool out of the remaining capacity of the mirrored OS drives and how to reconfigure a Storage Spaces mirror in the case of disk failure.

## Creating a mirrored volume

The procedures in this topic allow you to create a second boot disk to ensure that the operating system and data remain available even if either boot disk fails. To do this, you create a software mirror (RAID1) of your operating system. Once the mirror is created, the operating system and your data will be present on both boot disks, and the system software will keep data and changes to the operating system (such as registry updates) in sync on both boot disks.

### Creating a mirrored operating system volume for BIOS-based systems

**Prerequisites:** You should have a system with at least two disks. The second disk need not be identical to the primary disk—it can even be a different size or on a different bus. Disks with a native sector size of 512 bytes are recommended (in favor of those with an emulated sector size). However, USB disks, whether internal or external, cannot be used. You should be familiar with Diskpart and Bcdedit. You should already be familiar with concepts like partitions and disks. For background information on these topics, see [http://go.microsoft.com/fwlink/?LinkId=184841](http://go.microsoft.com/fwlink/?LinkId=184841).

Before you create the software mirror, ensure that the boot order in the BIOS is configured to use the primary disk first and the secondary disk second. Depending on your hardware, you may need to change the configuration of the disks’ connections. Consult your hardware documentation for details.

Creating the software mirror (RAID1) of the operating system involves several phases:

1. **Disable Hibernate.** Please, see hibernation section above.
2. **Move the Windows Recovery Environment to the System Partition**

3. **Clone the system partition from the primary disk to the secondary disk.** Computer firmware requires that each boot disk has a system partition. It is preferable that the first partition on each disk is the system partition.

4. **Mirror the operating system volume from the primary disk to the secondary disk.** This is the key portion of the procedure, which may take the longest to complete, as it scales directly with the size of the partition.

5. **Update the BCD store for the primary disk.**

6. **Update the BCD store for the secondary disk.** The secondary BCD store should be updated so that the system can boot from the secondary disk.

7. **Update the secondary plex entries on the secondary disk.**

   The following procedures involve creating and using several partitions with unique drive letters. These procedures are based on a simple retail installation—your installation may have different drive letters or disk numbers. You can use any drive letters corresponding to the roles in the table that are appropriate for your system but be careful to alter any commands that refer to the drive letters or disk numbers accordingly and consistently throughout all of the procedures.

   For your reference, the following table clarifies the various volumes and the corresponding letters as used in the procedures. In the course of the procedures, you will create all of the partitions in this table except the system partition (S:) on the primary disk and the primary plex of the operating system volume (C:) on the primary disk.

<table>
<thead>
<tr>
<th>Primary disk (disk 0)</th>
<th>Secondary disk (disk 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System partition (primary copy)</td>
<td>S:</td>
</tr>
<tr>
<td>Operating system volume (the primary plex of the mirror)</td>
<td>C:</td>
</tr>
<tr>
<td>Operating system volume (the primary plex of the mirror)</td>
<td>C:</td>
</tr>
</tbody>
</table>

Similarly, in the following procedures, **disk 0** refers to the primary disk and **disk 1** refers to the secondary disk. If the primary and secondary disks are numbered differently on your system, alter any commands accordingly.
This procedure assumes that the secondary disk contains no data or a partition table. If you have any important data on the secondary disk, back it up before starting this procedure.

**To disable hibernate**

In an elevated command prompt, type:

- `powercfg.exe /h off`

**To clone the system partition and move the Windows Recovery Environment**

First, start Diskpart by typing `Diskpart.exe` at an elevated command prompt. Then create the secondary system partition and prepare to copy the contents of the partition using the following commands at the Diskpart prompt in order:

- Select disk 1
- Create partition primary size=350
- active
- format fs=ntfs quick label="System Reserved"
- assign letter=t
- select disk 0
- select partition 1
- assign letter=s

Move Windows RE to the system partition with the following commands at an elevated command prompt, if it does not reside there yet:

- `Reagentc.exe /disable`
- `Robocopy.exe C:\Windows\System32\Recovery S:\Recovery\WindowsRE /copyall /dcopy:t`
- `reagentc.exe /setreimage /path S:\Recovery\WindowsRE`
- `Reagentc.exe /enable`

Copy the contents of the primary system partition to the secondary system partition using this command at an ordinary elevated command prompt (that is, not at a Diskpart prompt):

**Note**

This procedure assumes that the secondary disk contains no data or a partition table. If you have any important data on the secondary disk, back it up before starting this procedure.
• robocopy.exe s:\ t:\ * /e /copyall /dcopy:t /xf BCD.* /xd "System Volume Information"

**To mirror the operating system volume**

First, start Diskpart by typing Diskpart.exe at an elevated command prompt. If the primary and secondary disks are not already dynamic disks, convert them to dynamic using the following commands at the Diskpart prompt in order:

- Select disk 1
- Convert dynamic
- Select disk 0
- Convert dynamic

Now that the primary and secondary disks are dynamic disks, mirror the boot volume using the following commands in order:

- select volume=c
- add disk=1 wait

**Note**

This last command commences the mirroring operation immediately. Depending on the size of the operating system volume, this operation may proceed quickly or it may take a considerable time—it is best to avoid restarting the computer until the operation completes.

**To update the BCD store on the primary disk**

1. At an elevated command prompt, run Bcdedit.exe /export t:\boot\BCD
2. Run Bcdedit.exe /store s:\boot\BCD /enum all
3. Note the identifier for each of the following entries:

<table>
<thead>
<tr>
<th>Entry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resume from Hibernate</td>
<td>Windows Resume Application – secondary plex</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Server 2012 – secondary</td>
</tr>
</tbody>
</table>
4. Run `Bcdedit.exe /store s:\boot\BCD /delete {identifier}`, where `{identifier}` is the identifier for the Resume from Hibernate entry with the description Windows Resume Application – secondary plex.

5. Run `Bcdedit.exe /store s:\boot\BCD /delete {identifier}`, where `{identifier}` is the identifier for the Windows Boot Loader entry with the description Windows Server 2012 – secondary plex.

To update the BCD store on the secondary disk

1. At an elevated command prompt, run `Bcdedit.exe /store t:\boot\BCD /enum all`.

2. Note the identifier for each of the following entries. You will use these identifiers in several steps that follow.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Options</td>
<td>Ramdisk Options</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Recovery Environment</td>
</tr>
<tr>
<td>Resume from Hibernate</td>
<td>Windows Resume Application</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Server 2012</td>
</tr>
</tbody>
</table>

3. First, convert the primary plex entries to secondary plex entries in the secondary BCD store using the following commands at an ordinary elevated command prompt:

   - `Bcdedit.exe /store t:\boot\BCD /set {identifier} ramdisksdidevice partition=t:`, where `{identifier}` is the identifier for the Device Options entry.
   - `Bcdedit.exe /store t:\boot\BCD /set {memdiag} device partition=t:`
   - `bcdedit.exe /store t:\boot\BCD /set {identifier1} device ramdisk=[t:]\Recovery\WindowsRE\Winre.wim,{identifier2}`, where `{identifier1}` is the identifier for the Windows Boot Loader entry with the description Windows Recovery Environment and `{identifier2}` is the identifier for the Device Options entry.
   - `bcdedit.exe /store t:\boot\BCD /set {identifier1} osdevice ramdisk=[t:]\Recovery\WindowsRE\Winre.wim,{identif{identifier2},`
where \{identifier1\} is the identifier for the Windows Boot Loader entry with the description Windows Recovery Environment and \{identifier2\} is the identifier for the Device Options entry.

- bcdedit.exe /store t:\boot\BCD /set {bootmgr} device partition=t:

4. Remove the remaining primary plex entries from the secondary BCD store by running the following commands at an elevated command prompt:
   - bcdedit.exe /store t:\boot\BCD /delete \{identifier\}, where \{identifier\} is the identifier for the Resume from Hibernate entry from Step 2.
   - bcdedit.exe /store t:\boot\BCD /delete \{identifier\}, where \{identifier\} is the identifier from Step 2 for the entry Windows Boot Loader with description Windows Server 2012.

**To update the secondary plex entries on the secondary disk**

1. At an elevated command prompt, run Bcdedit.exe /store t:boot\BCD /enum all

2. Note the identifier for each of the following entries. You will use these identifiers in several steps that follow.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resume from Hibernate</td>
<td>Windows Resume Application – secondary plex</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Recovery Environment</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Server 2012– secondary plex</td>
</tr>
</tbody>
</table>

3. Run each of the following commands at an ordinary elevated command prompt:
   - Bcdedit.exe /store t:\boot\BCD /set \{identifier\} description “Windows Resume Application”, where \{identifier\} is the identifier for the Resume from Hibernate entry with the description Windows Resume Application – secondary plex.
   - Bcdedit.exe /store t:\boot\BCD /set \{identifier\} description “Windows Server 2012”, where \{identifier\} is the identifier for the Windows Boot Loader entry with the description Windows Server
Bcdedit.exe /store t:\boot\BCD /set {identifier1} resumeobject {identifier2}, where {identifier1} is the identifier for the Windows Boot Loader entry with the description Windows Server 2012 – secondary plex and {identifier2} is the identifier for the Resume from Hibernate entry with the description Windows Resume Application – secondary plex.

Bcdedit.exe /store t:\boot\BCD /set {identifier1} recoverysequence {identifier2}, where {identifier1} is the identifier for the Windows Boot Loader entry with the description Windows Server 2012 – secondary plex and {identifier2} is the identifier for the Windows Boot Loader entry with the description Windows Recovery Environment.

Start Diskpart by typing Diskpart.exe at an elevated command prompt, and then run the following two commands at the Diskpart prompt:

- Select volume=t
- remove
- Select volume=s
- remove

Creating a mirrored operating system volume for UEFI-based systems

Prerequisites: You should have a system with at least two disks. The second disk need not be identical to the primary disk—it can even be a different size or on a different bus. Disks with a native sector size of 512 bytes are recommended (in favor of those with an emulated sector size). However, USB disks, whether internal or external, cannot be used. You should be familiar with Diskpart and Bcdedit. You should already be familiar with concepts like
partitions and disks. For background information on these topics, see http://go.microsoft.com/fwlink/?LinkId=184841.

Creating the software disk mirror (RAID1) involves several phases:

1. **Disable Hibernate.** Please, see hibernation section above.

2. **Set up and clone the Windows Recovery Environment (Windows RE) on its own partition, if it is not already configured that way.**

3. **Clone the system partition from the primary disk to the secondary disk.** Computer firmware requires that each boot disk have a system partition. It is preferable that the first partition on each disk is the system partition.

4. **Mirror the operating system volume from the primary disk to the secondary disk.** This is the key portion of the procedure, which may take the longest to complete.

5. **Update the BCD store for the primary disk.**

6. **Update the BCD store for the secondary disk:** The secondary BCD store should be updated so that the system can boot from the secondary disk automatically.

7. **Update secondary plex entries on the secondary disk.**

The following procedures involve creating and using several partitions with unique drive letters. These procedures are based on a simple retail installation—your installation may have different drive letters or disk numbers. You can use any drive letters corresponding to the roles in the table that are appropriate for your system but be careful to alter any commands that refer to the drive letters or disk numbers accordingly and consistently throughout all of the procedures.

For your reference, the following table clarifies the various volumes and the corresponding letters as used in the procedures. In the course of the procedures, you will create all of the partitions in this table except the system partition (S:) on the primary disk and the primary plex of the operating system volume (C:) on the primary disk.

Note

This procedure assumes that the secondary disk contains no data or a partition table. If you have any important data on the secondary disk, back it up before starting this procedure.
<table>
<thead>
<tr>
<th>Primary disk (disk 0)</th>
<th>Secondary disk (disk 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery Partition (primary copy)</td>
<td>Q:</td>
</tr>
<tr>
<td>System partition (primary copy)</td>
<td>S:</td>
</tr>
<tr>
<td>Operating system volume (the primary plex of the mirror)</td>
<td>C:</td>
</tr>
<tr>
<td></td>
<td>Recovery Partition (secondary copy)</td>
</tr>
<tr>
<td></td>
<td>R:</td>
</tr>
<tr>
<td></td>
<td>System partition (secondary copy)</td>
</tr>
<tr>
<td></td>
<td>T:</td>
</tr>
<tr>
<td></td>
<td>Operating system volume (the secondary plex of the mirror)</td>
</tr>
<tr>
<td></td>
<td>C:</td>
</tr>
</tbody>
</table>

Similarly, in the following procedures, **disk 0** refers to the primary disk and **disk 1** refers to the secondary disk. If the primary and secondary disks are numbered differently on our system, alter any commands accordingly.

**To disable hibernate**

In an elevated command prompt, type:

- `powercfg.exe /h off`

**To clone the recovery partition**

1. First, start Diskpart by typing `Diskpart.exe` at an elevated command prompt. Then create the secondary recovery partition using the following commands at the Diskpart prompt in order:

   - **Select disk 0**
   - **Select partition 1**
   - **Detail partition**

2. At this point, note the ID of this partition type.

   - **Select disk 1**
   - **Convert gpt**
   - **Select partition 1**
   - **Delete partition override**
   - **Create partition primary size=300**
   - **Format fs=ntfs quick label=Recovery**
   - **Select partition 1**
- **Set id=**identifier (where identifier is the GUID noted from step 2)

3. Assign drive letters to the newly created partitions
   - Select disk 0
   - Select partition 1
   - Assign letter=q
   - Select disk 1
   - Select partition 1
   - Assign letter=r

To set up the Windows Recovery Environment on its own partition

⚠️ **Note**

If Windows Recovery Environment is already on a separate partition, perhaps as a result of configuring a mirror previously, you should skip this procedure and move on to “clone the system partition.”

1. Move Windows RE to the primary recovery partition you just created with the following commands at an elevated command prompt:
   - Reagentc.exe /disable
   - Robocopy.exe C:\Windows\System32\Recovery\ Q:\Recovery\WindowsRE\ /copyall /dcopy:t
   - reagentc.exe /setreimage /path Q:\Recovery\WindowsRE
   - Reagentc.exe /enable

2. Copy the contents of the primary recovery partition to the secondary recovery partition using this command at an ordinary elevated command prompt (that is, not at a Diskpart prompt):
   - robocopy.exe q:\ r:\ * /e /copyall /dcopy:t /xd "System Volume Information"

To clone the system partition
1. First, start Diskpart by typing Diskpart.exe at an elevated command prompt. Then create the secondary system partition and prepare to copy the contents of the partition using the following commands at the Diskpart prompt in order:
   - Select disk 1
   Note: If you are using 4k native HDDs, set the EFI size in the following step to 260
   - Create partition efi size=100
   - Format fs=fat32 quick
   - assign letter=t
   - Create partition msr size=128
   - select disk 0
   - select partition 2
   - assign letter=s

2. Copy the contents of the primary system partition to the secondary system partition using this command at an ordinary elevated command prompt (that is, not at a Diskpart prompt):
   - robocopy.exe s:\ t:\ * /e /copyall /dcopy:t /xf BCD.* /xd "System Volume Information"

To mirror the operating system volume

First, start Diskpart by typing Diskpart.exe at an elevated command prompt. If the primary and secondary disks are not already dynamic disks, convert them to dynamic using the following commands at the Diskpart prompt in order:
   - Select disk 1
   - Convert dynamic
   - Select disk 0
   - Convert dynamic

Now that the primary and secondary disks are dynamic disks, mirror the boot volume using the following commands in order:
   - select volume=c
• add disk=1 wait

**Note**
This last command commences the mirroring operation immediately. Depending on the size of the operating system volume, this operation may proceed quickly or it may take a considerable time—it is best to avoid restarting the computer until the operation completes.

**To update the BCD store on the primary disk**

1. At an elevated command prompt, run `bcdedit.exe /enum all` and note the identifier for the Windows Boot Manager entry which has the description Windows Boot Manager or Windows Boot Manager – Primary Disk.

2. If the description for this entry is already Windows Boot Manager – Primary Disk, proceed to the next step. Otherwise, run `bcdedit.exe / set {identifier} description “Windows Boot Manager – Primary Disk”, where {identifier} is the identifier from Step 1.

   **Note**
   Be sure to include the curly brackets whenever you enter an {identifier}.

3. Run `bcdedit.exe /copy {identifier} /d “Windows Boot Manager – Secondary Disk”, where {identifier} is the identifier from Step 1. Note the identifier for the entry Windows Boot Manager – Secondary Disk.

4. Run `bcdedit.exe /set {identifier} device partition=t:`, where {identifier} is the identifier you noted for Windows Boot Manager – Secondary Disk in the previous step.

5. Run `Bcdedit.exe /enum all`.

6. Note the identifier for each of the following entries:

<table>
<thead>
<tr>
<th>Entry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resume from Hibernate</td>
<td>Windows Resume Application – secondary plex</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Server 2012 – secondary plex</td>
</tr>
</tbody>
</table>

7. Run `Bcdedit.exe /export t:\EFI\Microsoft\boot\BCD`
8. Run Bcdedit.exe /store s:\EFI\Microsoft\Boot\BCD /delete {identifier}, where {identifier} is the identifier for Resume from Hibernate.

9. Run Bcdedit.exe /store s:\EFI\Microsoft\Boot\BCD /delete {identifier}, where {identifier} is the identifier for Windows Boot Loader.

**To update the BCD store on the secondary disk**

1. At an elevated command prompt, run Bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /enum all

2. Note the identifier for each of the following entries. You will use these identifiers in several steps that follow.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Options</td>
<td>Ramdisk Options</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Recovery Environment</td>
</tr>
<tr>
<td>Resume from Hibernate</td>
<td>Windows Resume Application</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Server 2012</td>
</tr>
<tr>
<td>Windows Boot Manager</td>
<td>Windows Boot Manager – Primary Disk</td>
</tr>
<tr>
<td>Resume from Hibernate</td>
<td>Windows Resume Application – secondary plex</td>
</tr>
<tr>
<td>Windows Boot Loader</td>
<td>Windows Server 2012 – secondary plex</td>
</tr>
<tr>
<td>Windows Boot Manager</td>
<td>Windows Boot Manager – secondary disk</td>
</tr>
</tbody>
</table>

3. First, convert the primary plex entries to secondary plex entries in the secondary BCD store using the following commands at an ordinary elevated command prompt:

   - Bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier} ramdisksdidevice partition=r:, where {identifier} is the identifier for the Device Options entry.
   - Bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {memdiag} device partition=t:
   - bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier1} device ramdisk=[r:]\Recovery\WindowsRE\Winre.wim,{identifier2}, where {identifier1} is the identifier for the Windows Boot Loader entry with the description Windows Recovery Environment and {identifier2} is the identifier for the Device Options entry.
• `bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier1} osdevice` ramdisk=[r:\]Recovery\WindowsRE\Winre.wim,{identifier2}, where
  `{identifier1}` is the identifier for the Windows Boot Loader entry with
  the description Windows Recovery Environment and `{identifier2}` is the
  identifier for the Device Options entry.

4. Remove the remaining primary plex entries from the secondary BCD store
by running the following commands at an elevated command prompt:

• `bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /delete {identifier}`, where
  `{identifier}` is the identifier for the Resume from Hibernate entry with
  the description Windows Resume Application.

• `bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /delete {identifier}`, where
  `{identifier}` is the identifier for Windows Boot Loader with the
  description Windows Server 2012.

• `bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /delete {identifier} /f`,
  where `{identifier}` is the identifier for Windows Boot Manager with the
  description Windows Boot Manager – Primary Disk.

5. Update the secondary plex entries in the secondary BCD store by running
the following commands at an elevated command prompt:

• `bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier} description
  “Windows Resume Application”`, where `{identifier}` is the identifier for
  the Resume from Hibernate entry with description Windows Resume
  Application – secondary plex that you noted earlier.

• `bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier} description
  “Windows Server 2012”`, where `{identifier}` is the identifier for the
  entry Windows Boot Loader with the description Windows Server 2012
  – secondary plex.

• `bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier1}
  resumeobject {identifier2}`, where `{identifier1}` is the identifier for the
  entry Windows Boot Loader with the description Windows Server 2012
  – secondary plex and `{identifier2}` is the identifier for the entry
  Resume from Hibernate with the description Windows Resume
  Application – secondary plex.

• `bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier1}
  recoverysequence {identifier2}`, where `{identifier1}` is the identifier for
  the entry Windows Boot Loader with the description Windows Server
  2012 – secondary plex and `{identifier2}` is the identifier for the entry
  Windows Boot Loader with the description Windows Recovery
  Environment.
- bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier1} default {identifier2}, where {identifier1} is the identifier for the entry Windows Boot Manager with the description Windows Boot Manager – Secondary Disk and {identifier2} is the identifier for the entry Windows Boot Loader with the description Windows Server 2012 – secondary plex.

- bcdedit.exe /store t:\EFI\Microsoft\boot\BCD /set {identifier1} resumeobject {identifier2}, where {identifier1} is the identifier for the entry Windows Boot Manager with the description Windows Boot Manager – secondary disk and {identifier2} is the identifier for the entry Resume from Hibernate with the description Windows Resume Application – secondary plex.

To update the secondary plex entries on the secondary disk

1. At an elevated command prompt, run bcdedit.exe /enum all and note the identifier for the entry Windows Boot Manager with the description Windows Boot Manager – Secondary Disk.

2. Run bcdedit.exe /set {fwbootmgr} displayorder {identifier} /addfirst, where {identifier} is the identifier from Step 1.

3. Restart the computer with the command shutdown.exe /r /t 0.

4. Once the computer has restarted, start Diskpart by typing Diskpart.exe at an elevated command prompt, and then run the following commands at the Diskpart prompt:
   - Select disk 0
   - Select partition 2
   - Assign letter=s
   - Select disk 1
   - Select partition 2
   - Assign letter=t

5. At an ordinary elevated command prompt, run bcdedit.exe /store s:\EFI\Microsoft\boot\BCD /enum all and note the identifier for the entry Windows Boot Manager with the description Windows Boot Manager – Secondary Disk.
6. Run `Bcdedit.exe /store s:\EFI\Microsoft\boot\BCD /delete {identifier}`, where `{identifier}` is the identifier you noted in the previous step.

8. At the ordinary elevated command prompt, run `bcdedit.exe /enum all` and note the identifier for the entry `Firmware Application {101fffff}` with the description `Windows Boot Manager – Primary Disk`.

9. Run `bcdedit.exe /set {fwbootmgr} displayorder {identifier} /addfirst`, where `{identifier}` is the identifier you noted in the previous step.

10. At an ordinary elevated command prompt, run `bcdboot c:\windows`

11. Run `bcdedit /enum firmware` and note the identifier for the entry `Windows Boot Manager` with the description `Windows Boot Manger – Secondary Disk`.

12. Run `bcdedit /delete {identifier}` where `{identifier}` is the identifier you noted in the previous step.

13. Run `bcdedit /set {bootmgr} description “Windows Boot Manager – Secondary Disk”`

14. Run `bcdedit /enum firmware` and note the identifier for the entry `Firmware Application {101fffff}` with the description `Windows Boot Manager – Primary Disk`.

15. Run `bcdedit.exe /set {fwbootmgr} displayorder {identifier} /addfirst`, where `{identifier}` is the identifier you noted in the previous step.

16. Restart the computer through the primary system partition with the command `shutdown.exe /r /t 0`.

**Reconfiguring the mirror after a disk failure**

Once you have configured the disk mirror as described in this document, if the primary operating system disk completely fails, the computer should switch to booting from the mirrored operating system on the secondary disk. However, at that point the computer once again has effectively only a single operating system disk, even though the system is still configured to support the mirrored configuration. Also, the system is vulnerable should the secondary disk fail, so it is best to replace the failed disk and re-establish the disk mirror as soon as is practicable.

This topic explains how to reconfigure the system to operate properly with only a single operating system disk. Once you have replaced the failed disk,
you can re-construct the mirrored configuration by repeating the steps in Creating a mirrored volume.

Reconfiguring after a disk failure in a mirrored operating system volume for BIOS-based computers
Prerequisites: You must have already configured a mirrored operating system volume as described in Creating a mirrored volume. These procedures assume that the operating system volume on your system is C:.

Since one disk in the mirror has failed, you must first replace the failed physical disk, and then reconfigure the remaining functional disk.

To replace the failed disk and prepare the remaining disk
1. Remove the failed disk.
2. If the failed disk was the primary disk (that is, the secondary disk is still working properly), disconnect the secondary disk cable and connect the primary disk cable to it.
3. Install the replacement disk and connect the secondary disk cable to it.
4. Start Diskpart by typing Diskpart.exe at an elevated command prompt. Then remove the relevant data for the missing system partition, boot volume plex, and recovery partition with the following commands at the Diskpart prompt:
   - Select volume=c
   - Break disk=m0 nokeep
   - Select disk m0
   - Delete disk override
5. If the functional disk (that is, the one you did not have to replace) was the secondary disk, make it the primary disk with the following commands at a Diskpart prompt:
   - List volume (Note the numerical identifiers for the system volume, eg. 1 or 2.)
   - **Select volume identifier** (where **identifier** is the numerical identifier for the system volume)
   - **Assign letter=s**
6. At an ordinary command prompt, run the following commands:
   - Bcdedit.exe /import s:\boot\BCD
Reagentc.exe /disable
Reagentc.exe /setreimage /path s:\Recovery\WindowsRE
Reagentc.exe /enable

7. Return to the Diskpart prompt and run the following two commands:
   - Select volume=s
   - Remove

8. Re-construct the mirrored configuration by repeating the steps in Creating a mirrored volume.

Reconfiguring after a disk failure in a mirrored operating system volume for UEFI-based computers

Prerequisites: You must have already configured a mirrored operating system volume as described in Creating a mirrored volume. These procedures assume that primary plex of the operating system volume on your system is C:.

Since one disk in the mirror has failed, you must first replace the failed physical disk, and then reconfigure the remaining functional disk.

To replace the failed disk and prepare the remaining disk
1. Remove the failed disk.

2. If the failed disk was the primary disk (that is, the secondary disk is still working properly), disconnect the secondary disk cable and connect the primary disk cable to it.

3. Install the replacement disk and connect the secondary disk cable to it.

4. Start Diskpart by typing Diskpart.exe at an elevated command prompt. Then remove the relevant data for the missing system partition, boot volume plex, and recovery partition with the following commands at the Diskpart prompt:
   - Select volume=c
   - Break disk=m0 nokeep
   - Select disk m0
   - Delete disk override

5. If the functional disk (that is, the one you did not have to replace) was the secondary disk, make it the primary disk with the following commands at a Diskpart prompt:
List volume (Note the numerical identifiers for the system volume and recovery volume, eg. 1 or 2.)

Select volume identifier (where identifier is the numerical identifier for the system volume)

Assign letter=s

Select volume identifier (where identifier is the numerical identifier for the recovery volume)

Assign letter=q

6. At an ordinary command prompt, run the following commands:
   - Bcdedit.exe /import s:\EFI\Microsoft\boot\BCD /clean
   - Reagentc.exe /disable
   - Reagentc.exe /setreimage /path q:\Recovery\WindowsRE
   - Reagentc.exe /enable

7. Return to the Diskpart prompt and run the following commands:
   - Select volume=s
   - Remove
   - Select volume=q
   - Remove

8. Update the primary BCD store by opening an ordinary command prompt and running Bcdedit.exe /enum all.

9. If the failed disk was the primary disk, note the identifier for the Firmware Application (101fff) entry with the description Windows Boot Manager - Primary Disk.

10. If the failed disk was the secondary disk, note the identifier for the Firmware Application (101fff) entry with the description Windows Boot Manager - Secondary Disk.

11. Run Bcdedit.exe /delete {identifier}, where identifier is the appropriate identifier you noted in the previous steps.

12. If the remaining functional disk is the secondary disk (that is, if the failed disk was the primary disk), configure the secondary disk to be the primary disk by running Bcdedit.exe /enum all.

13. Note the identifier for the Windows Boot Manager entry with the description
14. Run `Bcdedit.exe /set {identifier} description “Windows Boot Manager - Primary Disk”` where `{identifier}` is the identifier you noted in the previous step.

15. Re-construct the mirrored configuration by repeating the steps in Creating a mirrored volume.

Configuring a pool and storage spaces on dynamic volumes

Using the excess capacity of boot disks for a storage pool is only supported on UEFI systems. Due to the nature of the mirrored boot disks, it is advised to only deploy mirror or parity spaces when using the excess capacity of boot disks. The below steps will create a mirror space across two mirrored dynamic boot volumes under the assumption of no other disks in the system.

Creating the storage pool

In a Windows PowerShell session with elevated user rights type:

- `Get-PhysicalDisk`
  The last command will store the two system disks in the $disk variable. If you have multiple disks in the system, ensure that only the two system disks are stored in $disk.

- `New-StoragePool –StorageSubSystemFriendlyName *Spaces* -FriendlyName identifier1 –PhysicalDisks $disk`, where `identifier1` is a name you would like to give your storage pool.
  To verify that your storage pool has been created, you can type the following (optional):
  - `Get-StoragePool`
  If your pool has been created successfully it will appear in a list of storage pools.

Creating and formatting a mirror space

To create a fully allocated mirror space, type the following in a Windows PowerShell session with elevated user rights:

- `New-VirtualDisk –StoragePoolFriendlyName identifier1 –FriendlyName identifier2 –ResiliencySettingName Mirror –UseMaximumSize –ProvisioningType`
Fixed, where \textit{identifier1} is the name of your storage pool from step 1 and \textit{identifier2} is the name you would like to give to your mirror space.

In order to initialize and format the newly created mirror space, type:

\begin{itemize}
  \item \texttt{$\text{space} | \text{Get-Disk} | \text{Initialize-Disk -PartitionStyle GPT}$}
  \item \texttt{$\text{part} = \text{space} | \text{Get-Disk} | \text{New-Partition -UseMaximumSize -DriveLetter identifier1}$}, where \textit{identifier1} is a free drive letter you would like to assign to this partition
\end{itemize}

After creation of the partition a pop-up should prompt you to format this new partition. You can either follow the format wizard or continue with the below steps:

\begin{itemize}
  \item \texttt{Format-Volume -Partition $\text{part} -\text{FileSystem NTFS -NewFileSystemLabel identifier1}$}, where \textit{identifier1} is the name you would like to give to your new volume
\end{itemize}

After the format completes you should be able to use your new mirror space volume just like any other volume on your system.

### Reconfiguring a mirror space after a disk failure

Reconfiguration of a spaces mirror should not be attempted until the boot mirror has been re-established. In order to reconfigure a spaces mirror after the failing of one of its disks it is necessary to take several steps:

1. Add a physical disk to the pool
2. Retire the failed disk
3. Repair the mirror
4. Remove the failed disk from the pool

#### 1. Adding a physical disk to the pool

In a Windows PowerShell session with elevated user rights type:

\begin{itemize}
  \item \texttt{Get-StoragePool}, and note the “FriendlyName” of the storage pool containing the affected spaces mirror
  \item \texttt{Get-PhysicalDisk}, and note the “FriendlyName” of the newly added mirror disk, i.e. the disk replacing the failed one.
  \item \texttt{$\text{disk} = \text{Get-PhysicalDisk -FriendlyName identifier1}$}, where \textit{identifier1} is the parameter just noted above.
  \item \texttt{Add-PhysicalDisk -StoragePoolFriendlyName identifier1 -PhysicalDisks $\text{disk}$}, where \textit{identifier1} is the name of the storage pool from the first step.
\end{itemize}

#### 2. Retiring the failed disk

In a Windows PowerShell session with elevated user rights type:
• $disk = Get-StoragePool –FriendlyName identifier1 | Get-PhysicalDisk | ? {$_._OperationalStatus –eq "Lost Communication"}, where identifier1 is the name of the storage pool from the first step.
• $disk | Set-PhysicalDisk –Usage Retired

3. Repairing the spaces mirror
In a Windows PowerShell session with elevated user rights type:

• Get-VirtualDisk | Repair-VirtualDisk
The above command will start the repair on any virtual disk that is degraded and schedule a storage job to run. This storage job will only run if the added disk is suitable for the mirror in question, i.e. it must have at least as much free capacity as the size of the mirror to be repaired. To confirm that the repair has started, type the following in a Windows PowerShell session with elevated user rights:

• Get-StorageJob
(Alternatively, you can query the name of your space via Get-VirtualDisk and only repair that individual space by typing Repair-VirtualDisk - FriendlyName identifier1, where identifier1 is the name of your storage space.)

4. Removing the failed disk from the storage pool
Once the storage job has finished repairing the mirror space the missing and retired disk can be removed from the pool. In a Windows PowerShell session with elevated user rights type:

• Remove-PhysicalDisk –StoragePoolFriendlyName identifier1 –PhysicalDisks $disk, where identifier1 is the name of the storage pool from the first step.
At this point you should have an intact mirror space again.