

Using the vgmodify command to perform LVM Volume Group Dynamic LUN Expansion (DLE) and Contraction (DLC)



Abstract.....	3
Introduction.....	4
Overview.....	4
What can vgmodify do for me?	4
When would I want to use vgmodify?.....	4
vgmodify for Version 1.0 volume groups	5
Increasing the range of values vgmodify provides.....	5
Command usage	5
Volume group configuration changes	6
Changing disk type (boot/non-boot) and impact of boot disks	6
Dynamic LUN expansion (DLE) and dynamic LUN contraction (DLC).....	6
Physical extent renumbering (-n option) and pvmove enhancement	7
How the volume group parameter settings affect the metadata size	8
Configuration backup files, restore script, and vgcfgrestore changes	8
Making better use of the alternate bad block pool space.....	9
Optimization of max_pv and max_pe values	9
Guidance on choosing the max_pv and max_pe values	9
Offline vgmodify	10
Prerequisites	10
Offline vgmodify procedures.....	10
Online vgmodify	12
Prerequisites	12
Online vgmodify procedures.....	13
Common Version 1.0 examples	14
Online DLE examples	14
Offline DLE examples.....	20
Online and offline DLC examples	24
Online and offline volume group configuration change examples.....	36
LVM vgmodify Messages for Version 1.0 volume groups	47
vgmodify for Version 2.0 volume groups	50
Command differences between Version 1.0 and 2.x volume groups	50
Command similarities between Version 1.0 and 2.x volume groups.....	50

Command line options.....	50
Command usage	51
Online DLE to increase the space available for user data	51
Online DLE to increase the space available for LVM configuration data	51
Online reprovisioning to increase the maximum volume group size	51
Online DLC to decrease the space used by a physical volume	52
Online reprovisioning to decrease the maximum volume group size	52
Online vgmodify	52
Prerequisites	52
Online DLE	52
Online DLC.....	53
Online reprovisioning to increase the maximum volume group size	53
Online reprovisioning to decrease the maximum volume group size	54
Common Version 2.x examples	54
Online DLE examples	55
Online reprovisioning examples	61
Online DLC examples	68
LVM vgmodify Messages for Version 2.x volume groups.....	76
For More Information	80
Call to action	80

Abstract

The Logical Volume Manager (LVM) `vgmodify` command enables you to change attributes that previously were set at creation time (for example, increasing the maximum number of physical volumes or the maximum number of extents). It also enables you to resize disks either through Dynamic LUN Expansion (DLE) or Dynamic LUN Contraction (DLC). The ability to resize disks is a feature commonly provided by disk arrays. This paper explains the benefits of `vgmodify` and how to use it.

The `vgmodify` command interface is available on HP-UX 11i v2 with the PHCO_35524 patch (except `-C`, online DLC) and on 11i v3.

Introduction

LVM and MirrorDisk/UX now support the following volume groups:

- Version 1.0 — Supported on all current and previous versions of HP-UX 11i.
- Version 2.x — Version 2.0 volume groups are supported starting with the HP-UX 11i v3 March 2008 Update. Version 2.1 volume groups are supported starting with the HP-UX 11i v3 September 2008 Update.

The `vgmodify` command is supported on Version 1.0 and Version 2.x volume groups. Version 2.x support is provided starting with the HP-UX 11i v3 March 2009 Update.

For further details on the newly supported volume group versions, see the *LVM Version 2.0 Volume Groups in HP-UX 11i v3* white paper.

Overview

What can `vgmodify` do for me?

The new `vgmodify` command enables you to alter some characteristics of an existing volume group (VG) or physical volume (PV) that were set with `vgcreate` or `pvcreate`. The modifiable attributes for Version 1.0 volume groups are the maximum number of PVs, the maximum number of Logical Volumes (LVs), the maximum number of extents per PV allowed in the VG, and whether a PV is to be bootable or not. The modifiable attribute for Version 2.x volume groups is the maximum size of the volume group. The `vgmodify` command handles the expansion (DLE) and contraction (DLC) of a LUN for both Versions 1.0 and 2.x.

Before the introduction of `vgmodify`, all these operations required the data in the volume group to be backed up and the volume group destroyed, or physical volume removed, before rebuilding and reloading the data.

You can use the `vgmodify` command in two modes:

- Offline `vgmodify` when the volume group is deactivated (supported for Version 1.0).
Enables you to change the characteristics of a volume group, and handles expansion and contraction (added in the HP-UX 11i v3 March 2009 Update) of a LUN.
- Online `vgmodify` when the volume group is active (supported for Versions 1.0 and 2.x).
Introduced in the HP-UX 11i v3 September 2008 Update, online `vgmodify` handles LUN expansion for Version 1.0 volume groups.

For the HP-UX 11i v3 March 2009 Update, online `vgmodify` enables you to change the characteristics of a volume group (Version 1.0 and 2.x volume groups), and handles expansion (Version 2.x volume groups) and contraction (Version 1.0 and 2.x volume groups) of a LUN.

When would I want to use `vgmodify`?

For Version 1.0 volume groups, use `vgmodify` to do the following tasks:

- Add more physical volumes than the max PV setting currently allows.
- Take account of a size change to a physical volume that was initialized via `pvcreate`.
- Make full use of the space available on a disk that is larger than the current maximum number of physical extents per physical volume allows.
- Make full use of the space available on a disk that is larger than the current configuration.
- Contract a physical volume to a size smaller than the current configuration.

- Change a disk type (boot to non-boot or vice versa).
- Change the maximum number of logical volumes in the volume group.

For Version 2.x volume groups, use `vgmodify` to do the following tasks:

- Make full use of the space available on a disk that is larger than the current configuration.
- Contract a physical volume to a size smaller than the current configuration.
- Change the maximum size.

vgmodify for Version 1.0 volume groups

Increasing the range of values `vgmodify` provides

The following method describes how to move one or more of the physical volumes into another volume group. After completing this task, you can add new disks or use `vgmodify` to increase the maximum number of physical extents per physical volume. This is only possible where the volume group (VG) has one group of logical volumes (LVs) using one set of physical volumes (PVs) and the remaining logical volumes using a different set of physical volumes (you can use `pvmove` to re-organize the layout if it does not already conform).

For example: VG has LVs 1, 2, and 3 on PVs 0 and 1. LVs 4, 5, and 6 on PVs 2, 3, 4, and 5.

```
# vgchange -a n VG
# vgexport -m MAP VG
# vgchgid PV2 PV3 PV4 PV5
# mkdir /dev/VG; mknod /dev/VG/group c 64 0xnn0000
# Where nn is the original volume group number.
# mkdir /dev/new_VG; mknod /dev/new_VG/group c 64 0xmm0000
# Where mm is the new volume group number.
# vgimport -m MAP /dev/VG PV0 PV1
# vgimport -m MAP /dev/new_VG PV2 PV3 PV4 PV5
# vgchange -a y -q n VG; vgchange -a y new_VG
# lvremove -f VG/LV4 VG/LV5 VG/LV6 new_VG/LV1 new_VG/LV2 new_VG/LV3
# vgreduce -f VG; vgreduce -f new_VG
# vgcfgbackup VG; vgcfgbackup new_VG
```

On completion, VG holds three LVs (1, 2, and 3) with PVs 0 and 1. While new_VG holds three LVs (4, 5, and 6) across PVs 2, 3, 4, and 5.

Remember to change any name references to the new volume group (for example, if the old LV4 is recorded in `/etc/fstab` it must be changed to `/dev/new_VG/LV4`).

Command usage

To run `vgmodify` on an activated volume group (online mode), invoke it with the `-a` option. To run `vgmodify` on a deactivated volume group (offline mode), invoke it without the `-a` option.

For online and offline modes, you can invoke the `vgmodify` command one of the following additional modes:

- Table mode. A table (`-t` option) of possible settings are displayed.
- Review mode. A review (`-r` option) is performed that the new settings, based upon the other arguments, can be successfully applied.
- Change mode. New settings are applied to the volume group.

Typically, you perform these in the preceding sequence.

For offline mode, if the volume group is deactivated, it is activated by `vgmodify` and `vgcfgbackup` called. The `vgmodify` command rejects starting on an active volume group if it is invoked in change mode. This is necessary as `vgmodify` must be in full control of the volume group, it must be able to choose the options used to activate it, and have the ability to deactivate it as necessary.

For online mode, `vgmodify` command expects the volume group to be active.

The configuration backup file (created by `vgcfgbackup`) is used to determine the volume group layout. The current size of each physical volume is obtained by interrogating each one directly.

Changing the volume group parameters affects the size of the LVM metadata. An area at the front of each physical volume is reserved to hold the LVM metadata. The `vgmodify` command can expand the LVM metadata if space before the first physical extent is available. It is also possible for `vgmodify` to utilize (where the `-n` option is used) the first physical extent, if free, for LVM metadata.

Where the options require it (change mode and changes are required), `vgmodify` builds a new configuration backup file based upon the new layout. For offline mode, the `vgmodify` command then invokes `vgcfgrestore` to apply this configuration to all of the physical volumes.

Volume group configuration changes

Changing disk type (boot/non-boot) and impact of boot disks

If a non-boot volume group contains bootable physical volumes, the volume group parameters available for selection are constrained by the boot disk. Therefore, by changing all boot disks in a non-boot volume group to non-boot, a wider choice of settings are available. Hence run `vgmodify` with `'-B n'` and a trailing list of all bootable physical volumes with all the `vgmodify` commands (including the `-t` option) where this is the situation. Disk type can be identified by running `vgcfgrestore -l -n vg name` or `pvdiskplay -d`.

If a physical volume is incorrectly converted from bootable to non-bootable, use `vgmodify` to reinstate the type. Note that for a physical volume to be converted to a boot disk either all its extents must be free or the first physical extent must start at block 2912 (as a user you cannot directly control the start block for the first physical extent, conversion to boot from non-boot is normally only possible if `vgmodify` was previously used to convert the same disk from boot to non-boot). Also the size of the LVM metadata structure VGRA (Volume Group Reserve Area) can be no greater than 768 Kb. To complete the process run `mkboot` and `lvlnboot` to rebuild the BDRA metadata.

Dynamic LUN expansion (DLE) and dynamic LUN contraction (DLC)

When a LUN is dynamically grown, use `vgmodify` to enable LVM to access this new space. After the volume group has been adjusted by `vgmodify`, you can allocate the new space using the normal LVM method by `lvextend` or `lvcreate`.

Prior to the HP-UX 11i v3 March 2009 Update, the physical volume on which DLC is performed is marked as unavailable from the device side. Starting with the HP-UX 11i v3 March 2009 Update, for a DLC, you must prepare the physical volume from the LVM side (to a size smaller than the current size) using the `vgmodify` command. Then, perform a DLC operation from the device side. If you do not prepare the physical volume for a DLC, the LUN is marked as unavailable.

Online DLE and online DLC are referred to as online disk resize operations. Use the following guidelines:

- If `pvcreate` was originally run with `-s` and a lower disk size value, `vgmodify` adjusts the setting to match its actual size using the DLE feature.
- For offline DLE, each time `vgmodify` is run it automatically obtains the current disk size and compares this with the size known to LVM. No additional options are required to handle a DLE event.

- For online DLE, you must use the `-a` and `-E` options to indicate that a DLE at the device side must be handled by LVM.
- DLE might require that the `max_pe` value is increased so that all the space can be allocated to physical extents. This can be achieved by including the `-e` option and an increased `max_pe` setting.
- You can perform an online disk resize operation while user I/Os to the physical volumes belonging to the volume group in question are in progress.
- Before contracting a physical volume, make certain the space being reduced is not associated with allocated extents. On HP-UX 11i v3, use the `-C` option to contract a physical volume. The `-C` option is not available on HP-UX 11i v2.
- The `vgmodify` command performs a physical volume size reduction only if the space being removed is held in extents that are free. If the extents are in use, `vgmodify` reports this condition and exits without making changes. To overcome this problem, increase the physical volume back to its original size (where possible). Then, try to reduce the size of the disk using `vgmodify` from the LVM side. If you cannot increase the size of the physical volume, you must free the extents associated with the device using `pvmove`, `lvreduce -k`, or `lvremove`.
- After the on-disk metadata reflects the changed configuration, the online disk resize process updates the configuration backup file for the volume group in question to reflect the changed configuration.
- After the online or offline DLE or DLC operation completes successfully, `vgmodify` takes a backup of the new volume group configuration and places it in the `/etc/lvmconf` directory.
- After an online disk resize operation is complete, use extreme care while using older configuration files. You must use a `vgcfgrestore -v1` on the files to verify that the disk size values match the current configuration. You must manually remove the old configuration files that hold out of date information.
- If you restored an older volume group configuration on to a physical volume on which a successful online resize operation has been completed, such a PV would not get attached during re-activation.

Physical extent renumbering (-n option) and pvmove enhancement

A side effect of changing the volume group parameters is that the LVM metadata (VGRA) might change size. The maximum size of the VGRA is limited by the physical extent size and it is replicated on all physical volumes in the volume group. To allow the VGRA to grow to its maximum size, you might need to make the first physical extent on each physical volume in the volume group free. This must be accomplished outside of `vgmodify` by using `pvmove`, `lvreduce`, or `lvremove`.

An enhancement to the `pvmove` command enables you to move the contents of physical extent zero thereby making it free.

A subsequent `vgmodify` command can reallocate an unused physical extent zero for metadata use. A consequence of this is that physical extents are renumbered lower (the old physical extent one becoming new physical extent zero). Logical extent numbering remains unchanged.

If the specified volume group parameters are sufficiently smaller than the existing settings, it is possible that the new VGRA is small enough to allow metadata space to be returned to physical extent space. When this occurs, physical extents are renumbered higher (space that was partially metadata now holding the new physical extent zero (automatically marked free) and the old physical extent zero becoming new physical extent one). Logical extent numbering remains unchanged.

Where a configuration permits both higher and lower renumbering (for example all physical extents free on all physical volumes in the volume group), `vgmodify` favors renumbering higher.

How the volume group parameter settings affect the metadata size

The choice of volume group settings is affected by the LVM metadata size. While the `max_lv` setting has only a small impact on the VGRA size (by default `vgcreate` has already set `max_lv` to the maximum possible value), the `max_pv` and `max_pe` settings are a major factor. As a general rule, if you reduce either the `max_pe` or `max_pv` values, you can increase the other (`max_pe` or `max_pv`). As a helpful approximation, halving one (`max_pe` or `max_pv`) allows the doubling of the other. For example, if you halve `max_pe`, you can approximately double `max_pv`.

Configuration backup files, restore script, and `vgcfgrestore` changes

The `vgmodify` command uses LVM configuration backup files in its operations. These backup files are used as a source of information about the volume group, and, if needed, can be used for recovery operations. Remember the following items:

- Each time `vgmodify` is used a new set of configuration backup file are created. This is done each time to ensure it is using the most up-to-date configuration details.
- The configuration files are stored in the `/etc/lvmconf` directory.
- Unless being run in review (`-r`) or table (`-t`) mode, `vgmodify` uses `vgcfgrestore` to apply the configuration to all the physical volumes. If the operation does not fully complete (for example, it is interrupted by a system crash), you can perform a manual restoration. To simplify a recovery, `vgmodify` creates a `vg_name_restore` script under `/etc/lvmconf`. The `vgmodify` command does not use this shell script. It is only provided for manual restoration to all physical volumes, taking into account any alternate paths.

With the introduction of `vgmodify`, the configuration files for a specific volume group might have different parameters. The `vgcfgrestore` command is enhanced and now offers a `-v` option, which is only applicable with `-l`, to additionally report from the configuration backup file the following parameters:

- The size of each physical volume.
- The start block for physical extent zero of each physical volume.
- The PVkey (see the `-k` option on `lvdisplay(1M)`) of each physical volume (paths with the same PVkey are links (PVlinks) to the same physical volume).
- The `max_pv` (maximum number of physical volumes in the volume group)
- The `max_pe` (maximum number of physical extents per physical volume)
- The `max_lv` (maximum number of logical volumes in the volume group) for the volume group.

After `vgmodify` has performed a modification, you must remove all old configuration backup files. However, if some remain and a restore is to be performed, use extreme care in using older configuration files. Issue a `vgcfgrestore -v1` on the file and verify the values match the current configuration. Compare the output of `vgcfgrestore -v1` on the two files. If the `max_pv`, `max_pe`, or `max_lv` values differ, use the output of `vgdisplay` to validate which set is current. If the size of a PV is different, use `diskinfo` on the raw device to check the current size. Manually remove old `lvmconf` files that hold out of date information.

Example output:

- With the `-v` option:

```
# vgcfgrestore -v1 -n vg01
Volume Group Configuration information in "/etc/lvmconf/vg01.conf"
VG Name /dev/vg01
---- Physical volumes : 2 ----
   PV      Type      Size (kb)      Start (kb)  PVkey
   c3t1d0  Non-Boot  1000000        1024        0
   c2t1d0  Non-Boot  1000000        1024        0
```

```
max_pv 16 max_pe 1016 max_lv 255 vg_version 1.0
```

- Without the `-v` option:
`vgcfgrestore -l -n vg01`
Volume Group Configuration information in `"/etc/lvmconf/vg01.conf"`
VG Name `/dev/vg01`
---- Physical volumes : 2 ----
 `/dev/rdisk/c3t1d0` (Non-bootable)
 `/dev/rdisk/c2t1d0` (Non-bootable)

Making better use of the alternate bad block pool space

Patches on `l1i v1` and `v2` have resulted in the bad block directory only being used for entries of pre-existing bad blocks as modern disk devices can perform their own handling of media errors. If the bad block directory is empty, `vgmodify` tries to return the space reserved for the alternate bad block pool to user data. In some cases the alternate bad block pool on a physical volume is greater than the extent size. When this is the case, and the `max_pe` is adequate, `vgmodify` increases the number of physical extents for the physical volume. When this happens, the number of free extents and total number of physical extents on the physical volume increases.

Optimization of `max_pv` and `max_pe` values

The values displayed in the `-t` output are not a complete set of all possible choices, but instead are the optimal ones. For example, if the output shows the following two adjacent lines:

<code>max_pv (-p)</code>	<code>max_pe (-e)</code>	Disk size (Mb)
35	2556	10224
39	2300	9200

You can apply a `max_pv` of 36, 37, or 38 to the volume group, but the highest `max_pe` for all of these is the same as for 39 (2300). Similarly, you can use a `max_pe` between 2557 and 2299, but the highest `max_pv` is 39. In reality, with a `max_pv` of 39, the `max_pe` can range from the highest physical extent in use on any physical volume in the volume group to 2300. With a `max_pe` of 2300, the `max_pv` can range from the number of physical volumes currently part of the volume group to 39. Therefore, `-t` output shows the optimal values, not the complete list. Or to put it another way the most sensible set of values to use.

The `-o` option instructs `vgmodify` to use the highest optimal `max_pv` and `max_pe` values. This option is most commonly used on volume groups that have not been modified by `vgmodify` and where you do not need to change any value. It is asking `vgmodify` to make best use of the metadata space.

Guidance on choosing the `max_pv` and `max_pe` values

When adjusting sizes of an existing or creating a new volume group, picking `max_pv` and `max_pe` has some side effects on the overall volume group configuration. It is best to provision for growth as best as possible. In general, the larger the extent size (this is the one parameter `vgmodify` cannot alter) the larger the volume group can grow. Use the following guidelines:

- From the table mode (the `-t` option), you can see how `max_pv`, `max_pe`, and disk size can be tuned for your specific needs or growth plans.
- If you plan to increase the number of physical volumes in the volume group, use the disk size and `max_pv` columns from the `-t` output to determine the `max_pv` setting. You must review the Logical Volume Management “Configuring for performance section” in the HP-UX Administrator's Guide for guidance on the number of volume groups. In general, keep the number of physical volumes to a minimum to improve performance.
- If you have plans to increase the largest size of disk in the volume group, use the `max_pv` and `max_pe` columns from the `-t` output to determine the size that best meets your needs.
- Choose a setting from the `'-t'` output that gives an adequate number of physical volumes of the largest size required.

- Physical extent renumbering enables more flexibility for picking `max_pv` and `max_pe`. If the `-t` output does not provide suitable values, check the `-tn` output.

Offline vgmodify

This section discusses the use of the `vgmodify` command on a deactivated volume group.

Prerequisites

- The volume group must be deactivated when changes are being made (for the root volume group this means booting into maintenance mode).
- The volume group must be cluster unaware (`vgchange -c n`) before changes are made. After `vgmodify` has altered the volume group, you can then make the volume group cluster aware (`vgchange -c y`).
- All physical volumes belonging to volume group must be accessible.
- There cannot be any entries in the bad block directory of any physical volume in the volume group. The `vgmodify` command reports any disks containing bad blocks and exit without making any changes. Use `pvdiskdisplay -d` to display the count of bad blocks and verify this is the cause of the failure. To overcome this problem, the disk can be replaced and the configuration restored with `vgcfgrestore`.

Offline vgmodify procedures

Performing an offline DLE

For an offline DLE, each time `vgmodify` is run it automatically obtains the current disk size and compares this with the size known to LVM. All physical volumes that are a part of a volume group are handled by default. No additional options are required to handle a DLE event.

1. Use the `vgmodify -t` option to determine the available settings that best meet your needs. Note: You can run the `vgmodify -t` operation against an activated or deactivated volume group.

```
# vgmodify -t -v vg02          # Table without physical extent renumbering
                               (For more information, see the Physical extent renumbering (-n
                               option) and pvmove enhancement section)
# vgmodify -t -v -n vg02      # Table with physical extent renumbering
```

Review the output and select the new values. You are responsible for freeing up the first physical extent on any physical volume as required by using `pvmove`, `lvreduce`, or `lvremove`.

2. Check that these can be applied. This step is particularly recommended when the volume group is currently active and in use. You can perform this step on an activated or deactivated volume group, as follows:

```
# vgmodify -r -p 150 -e 2000 -v vg02          # Note -r, review mode.
```

3. During a maintenance window, deactivate the volume group (for the root VG boot the volume group into maintenance mode), make it cluster unaware (if necessary), and run `vgmodify` to apply the new settings.

For a non-root volume group:

```
# vgchange -a n vg02          # Deactivate the volume group.
# vgmodify -v -e 2000 -p 150 vg02      # Same options and arguments as in
the previous step but without -r.
# vgchange -a y -s vg02        # Activate the volume group.
```

For a root volume group:

Boot into maintenance mode):

```
# cd / ; shutdown -r now
```

Interact with boot process:

```
ISL> hpux -lm
```

```
# vgmodify -v -e 2000 -p 150 vg02 # Same options and arguments as in
                                     the previous step but without -r.
# vgchange -a y -s vg02 # Verify the volume group activates with the new settings
# vgchange -a n vg02 # Deactivate volume group
# reboot
```

Performing an offline DLC

For an offline DLC, you must specify the size to which the physical volume must be reduced along with `-C` option. Specify the size in megabytes(m), gigabytes(g) , terabytes(t) or petabytes(p).

1. After deciding the correct size to which the physical volume must be contracted, use the `vgmodify` command to perform DLC from the LVM end.
2. You must use the review mode to ensure that a DLC on the disk now yields the desired results. Specify only one path with the `-C` option as follows:

```
# vgmodify -r -a -C dlc_size vg1 /dev/rdisk/disk53
                                     #Note -r, review mode.
```
3. Analyze the output of the preceding command and take the steps suggested by the review command. Then, perform the actual DLC operation in change mode with the suitable size. Before performing this operation, deactivate the volume group. For example:

```
# vgmodify -a n vg1
# vgmodify -a -C dlc_size vg1 /dev/disk/disk53
                                     #Note, same options and arguments as in
                                     the previous step, but without -r option.

# vgmodify -a y vg1
```

For handling the root and non-root volume groups, see the preceding [Performing an offline DLE](#) section.

Changing the volume group configuration

1. Run the `vgmodify` command with the `-t` option, which displays the range of values (`max_pv`, `max_pe`, and disk size) to which the volume group can be tuned. Note: You can run the `vgmodify -t` operation against an activated or deactivated volume group.

```
# vgmodify -t -v vg02 # Table without physical extent renumbering
                                     (For more information, see the section on physical extent renumbering.)
# vgmodify -t -v -n vg02 # Table with physical extent renumbering
```
2. Review the output and select the new values to which the volume group must be configured. You must free up the first physical extent on any physical volume as required, by using `pvmove`, `lvreduce`, or `lvremove`.
3. Use the `-r` option to check if the new values selected can be applied.

```
# vgmodify -r -v -e 2000 -p 150 vg02 # Note -r, review mode.
# vgmodify -r -o vg05 # For optimizing the volume group
```
4. Deactivate the volume group and run `vgmodify` to apply the new settings.

```
# vgmodify -a n vg02
# vgmodify -v -e 2000 -p 150 vg02
```

```
# vgmodify -a n vg02
```

For handling the root and non-root volume groups, see the preceding [Performing an offline DLE](#) section.

Online vgmodify

This section discusses the use of the `vgmodify` command on an activated volume group. Online `vgmodify` is supported starting with the HP-UX 11i v3 September 2008 Update release.

Beginning with the HP-UX 11i v3 September 2008 Update, you can use online `vgmodify` for Dynamic LUN Expansion. Beginning with the HP-UX 11i v3 March 2009 Update, you can also use online `vgmodify` for Dynamic LUN Contraction and to change the characteristics of a volume group.

Online `vgmodify` enables you to handle a LUN expansion and LUN contraction while the volume group is online. Most of the high end devices (for example, HP Enterprise Virtual Array) enable you to increase or decrease the capacity of a LUN without affecting the availability of the LUN. This is referred to as Dynamic LUN Expansion (DLE) and Dynamic LUN Contraction (DLC), respectively. The online `vgmodify` command enables you to take advantage of these features.

After a DLE using the device utilities, you can use online `vgmodify` to enable LVM to access this new space. After the volume group has been adjusted by `vgmodify`, you can allocate the new space using the normal LVM method by `lvextend` or `lvcreate`. Handling LUN expansion using online `vgmodify` is referred to as online DLE.

To use `vgmodify` for online DLE, you must explicitly specify the `-a` option (to indicate that this is an online operation) and the `-E` option (to indicate that the user desires to handle a DLE operation). You can either choose to handle DLE on all the disks belonging to the volume group or can explicitly list the physical volumes for which DLE needs to be handled. When you specify a set of physical volumes in conjunction with the `-E` option, the change in disk size of a physical volume not belonging to the specified set is ignored by online DLE.

Prior to using the LUN contraction capabilities at the device end, you must prepare the physical volume for a DLC (to a particular size smaller than the current size) using the `vgmodify` command. If you do not and perform a DLC, the LUN is marked as unavailable. Handling LUN contraction using online `vgmodify` is referred to as online DLC.

To use `vgmodify` for online DLC, you must explicitly specify the `-a` option (to indicate that this is an online operation) and the `-C` option (to indicate that the user desires to handle a DLC operation). The `-C` option expects the value to be specified, which is the new size to which `vgmodify` needs to prepare the physical volume for a DLC. The new size must always be less than the current size of the physical volume.

To use online `vgmodify` to change the characteristics of the volume group (like changing the `max_pv` settings or changing the number of logical volumes), you must specify the `-a` option (to indicate that this is an online operation) along with the other options. During this operation, the volume group is suspended and is resumed on completion of the configuration changes.

Prerequisites

- The volume group must be active.
- The volume group must not be activated in shared mode or read-only mode.
- The volume group must not be in a quiesced state.
- All physical volumes belonging to volume group must be accessible.
- There cannot be any entries in the bad block directory of any physical volume in the volume group. The `vgmodify` command reports any disks containing bad blocks and exit without making any changes. Use `pvdiskdisplay -d` to display the count of bad blocks and verify this

is the cause of the failure. To overcome this problem, the disk can be replaced and the configuration restored with `vgcfgrestore`.

- The volume group must not have a cluster lock physical volume. The `cmviewcl -v` command displays the device path name of the disk configured as a cluster lock LUN.
- The increase in disk size must be greater than the size of a physical extent on the physical volume.
- The number of extents allocated on the physical volume in question must not already be equal to the `max_pe` or `max_pv` for the volume group.

Online `vgmodify` procedures

Performing an online DLE

1. The trigger for dynamic expansion of a disk is usually when you find out that a configuration operation fails because of lack of space on a particular physical volume. For example, you have a contiguous logical volume on a particular physical volume PV1. You plan to extend this logical volume, but do not have the required space on PV1. In this case, one option is to dynamically expand the LUN and use `vgmodify` to take account of the size change.

2. Decide on the correct size to which to expand the LUN. Expanding the disk to a larger size arbitrarily might not be the right thing to do. Here, you can use `vgmodify` in table mode to decide on the optimal size to which the disk is to be expanded.

```
# vgmodify -t -v vg1      #Use the table output to determine the right size
                           for expansion. (Form ore information, see the Common
                           Version 1.0 examples.)
```

3. Perform the DLE operation using the relevant disk utilities.
4. Use the review mode to ensure that a DLE on the disk will yield the desired results as follows:

```
# vgmodify -v -r -a -E vg1      #Note -r, review mode.
```

5. Perform the actual DLE operation in the change mode as follows:

```
# vgmodify -a -E vg1      #Note, same options and arguments as in
                           the previous step, but without -r option.
```

Performing an online DLC

When you realize that you have over-provisioned for certain disks that are being used by LVM volume groups, perform a DLC operation. Follow these steps:

1. Decide the correct size to which to contract the physical volume.
2. Use the `vgmodify` command to perform the DLC from the LVM side.
3. Use the review mode to ensure that a DLC on the disk will yield the desired results. Note that you must specify the size to which the disk is to be reduced along with `-C` option. You must specify only one path with the `-C` option.

```
# vgmodify -r -a -C dlc_size vg1 /dev/rdisk/disk53
                           #Note -r, review mode.
```

Review the output and take the necessary steps suggested. Then, perform the operation with the suitable size.

4. Perform the actual DLC operation in the change mode.

```
# vgmodify -a -C dlc_size vg1 /dev/rdisk/disk53
                           #Note, same options and arguments as in the
                           previous step, but without -r option.
```

Changing the volume group configuration

1. Run the `vgmodify` command with the `-t` option, which displays the range of values (`max_pv`, `max_pe`, and disk size) to which the volume group can be tuned. For example:

```
# vgmodify -t -v vg02          # Table without physical extent renumbering
                                (For more information, see the Physical extent renumbering (-n
                                option) and pvmove enhancement section.)
# vgmodify -t -v -n vg02       # Table with physical extent renumbering
```
2. Review the output and select the new values to which the volume group has to be configured.
3. Use the `-r` option to check if the new values selected can be applied.

```
# vgmodify -r -v -e 2000 -p 150 vg02          # Note -r, review mode.
```
4. Perform the actual operation without the `-r` option, but with the `-a` option as follows:

```
# vgmodify -a -v -e 2000 -p 150 vg02        # Note -a
                                             indicates online operation
```

Common Version 1.0 examples

The examples in this section are applicable for both offline and online `vgmodify`.

In offline mode, the `vgmodify` command is invoked on a deactivated volume group. If required, `vgmodify` internally activates the volume group and deactivates it before completion. The messages about the activation and the deactivation of the volume group are displayed in the output.

In online mode, the `vgmodify` command operates on an activated volume group. You need to specify the `-a` option explicitly for online mode when changing the configuration.

Online DLE examples

The following examples assume the volume group is already activated.

Determining the correct size for a physical volume expansion

This example assumes you have a volume group with a 300 GB disk on which you have used up all the extents and want to add at least 150GB on this disk. That is, you want a new size of 450GB (460800MB) or more. Follow these steps:

1. Display the current state.

```
# vdisplay vg1
--- Volume groups ---
VG Name                /dev/vg1
VG Write Access        read/write
VG Status              available
Max LV                 255
Cur LV                1
Open LV                0
Max PV                 50
Cur PV                1
Act PV                1
Max PE per PV        30000
VGDA                   2
PE Size (Mbytes)      16
Total PE           19199
Alloc PE               19199
Free PE                0
Total PVG              0
Total Spare PVs        0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size            24000000m
VG Max Extents         1500000
```

```
# pvdisplay /dev/disk/disk4154
--- Physical volumes ---
PV Name                /dev/disk/disk4154
VG Name                /dev/vg1
PV Status              available
Allocatable            yes
VGDA                   2
Cur LV                1
PE Size (Mbytes)       16
Total PE               19199
Free PE                0
Allocated PE           19199
Stale PE               0
IO Timeout (Seconds)  default
Autoswitch             On
Proactive Polling     On
```

```
# diskinfo /dev/rdisk/disk4154
SCSI describe of /dev/rdisk/disk4154:
  vendor: HP
  product id: OPEN-V
  type: direct access
  size: 314572800 Kbytes
  bytes per sector: 512
```

The max_PE per PV for this volume group is 30000.

2. Run vgmodify in table mode as follows:

```
# vgmodify -t vg1
```

Current Volume Group settings:

	Max LV	255
	Max PV	50
	Max PE per PV	30000
	PE Size (Mbytes)	16
	VGRA Size (Kbytes)	12208
	VGRA space (Kbytes) without PE renumbering	12224
	VGRA space (Kbytes) PE renumbering lower	16384

Volume Group optimized settings (no PEs renumbered):

max_pv(-p)	max_pe(-e)	Disk size (Mb)
.	.	.
50	30204	483276
51	29436	470988
52	28924	462796

The volume group max_PE per PV is 30000. The output indicates the correct size for you to expand the disk size is about 483276 MB or 472 GB.

3. Perform the DLE operation from the device end and expand the disk to 470 GB.
4. Verify the new disk size with the diskinfo command:

```
# diskinfo /dev/rdisk/disk4154
SCSI describe of /dev/rdisk/disk4154:
  vendor: HP
  product id: OPEN-V
  type: direct access
  size: 492830720 Kbytes
  bytes per sector: 512
```

5. Use online vgmodify in review mode to review the effect of the change in disk size.

```
# vgmodify -v -r -a -E vg1
Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf
"/dev/rdisk/disk4154" size changed from 314572800 to 492830720kb
"/dev/rdisk/disk4154" size is limited by the maximum extents per PV
to 491520000.
```

An update to the Volume Group IS required
Review complete. Volume group not modified

6. Perform the actual DLE operation in change mode.

```
# vgmodify -a -E vg1
"/dev/rdisk/disk4154" size changed from 314572800 to 492830720kb
"/dev/rdisk/disk4154" size is limited by the maximum extents per PV
to 491520000.
```

```
# vgdisplay vg1
--- Volume groups ---
VG Name                /dev/vg1
VG Write Access        read/write
VG Status              available
Max LV                 255
Cur LV                1
Open LV                0
Max PV                 50
Cur PV                1
Act PV                1
Max PE per PV        30000
VGDA                   2
PE Size (Mbytes)      16
Total PE           30000
Alloc PE               19199
Free PE                10801
Total PVG              0
Total Spare PVs       0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size            240000000m
VG Max Extents         1500000
```

The total number of extents on the disk increased to 30000, which is also the max_PE per PV configured for the volume group.

Determining the physical volumes for online dynamic LUN expansion

To determine the physical volumes on which you can perform an online DLE operation, follow these steps:

1. Run `vgmodify -v -r -a -E vname`. Any disks that were resized since `pvcreate` was run on them are reported as follows:

```
"/dev/rdisk/c0t0d0" size changed from 16777216 to 100000000kb
```

If there is insufficient space to allocate all the disk space on any device, a message similar to the following appears:

```
"/dev/rdisk/c0t4d2" size is limited by the maximum extents per PV to
56934400.
```

If you want to change the volume group configuration parameters, follow the guidelines in the [Volume group configuration changes](#) section.

2. Use online `vgmodify` in review mode.

```
# vgmodify -v -r -a -E vg04
```

```
Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf
/dev/rdisk/disk43 Warning: Max_PE_per_PV for the volume group
(12900) too small for this PV (17501).
    Using only 12900 PEs from this physical volume.
/dev/rdisk/disk46 Warning: Max_PE_per_PV for the volume group
(12900) too small for this PV (17501).
    Using only 12900 PEs from this physical volume.
"/dev/rdisk/disk43" size changed from 52428800 to 71687369kb
"/dev/rdisk/disk43" size is limited by the maximum extents per PV
to 52838400.
"/dev/rdisk/disk47" size changed from 3145728 to 52428800kb
```

```
An update to the Volume Group IS required
Review complete. Volume group not modified
```

The results of the review indicate the /dev/rdisk/disk43 size increased since it was initialized with pvcreate. LVM has the correct size for /dev/rdisk/disk46, so it has not changed size since it was initialized with pvcreate. Both are unable to allocate all their space as the maximum number of PEs per PV setting is too low. The /dev/rdisk/disk47 size increased, and LVM can use all its new space.

3. Do an online DLE to use the additional space the can be accommodated using the current max_PE value.
Alternatively, change the max_PE value appropriately using online vgmodify to use all the additional disk space added. Then, perform the DLE (see the examples of physical extent renumbering in that section).

Performing online DLE when all additional disk space can be allocated

This example assumes you have a 50 GB disk belonging to volume group vg1 that has its max_PE per PV value set to 25535. The disk size was increased to 68 GB using the relevant disk utilities.

1. Review current volume group parameters.

```
# vgdisplay vg1
--- Volume groups ---
VG Name                /dev/vg1
VG Write Access        read/write
VG Status               available
Max LV                 255
Cur LV                 1
Open LV                 0
Max PV                 16
Cur PV                 1
Act PV                 1
Max PE per PV         25535
VGDA                   2
PE Size (Mbytes)       4
Total PE             12799
Alloc PE                12799
Free PE                 0
Total PVG               0
Total Spare PVs        0
Total Spare PVs in use 0
VG Version              1.0
VG Max Size             1634240m
VG Max Extents          408560
```

There are 12799 extents allocated on this physical volume.

2. Use online `vgmodify` in review mode to review the effect of the change in disk size.

```
# vgmodify -r -a -E vg1
"/dev/rdisk/disk43" size changed from 52428800 to 71687369kb
```

```
An update to the Volume Group IS required
Review complete. Volume group not modified
```

3. Use online `vgmodify` to change the disk size.

```
# vgmodify -a -E vg1
"/dev/rdisk/disk43" size changed from 52428800 to 71687369kb
```

4. Verify the change.

```
# vgsdisplay vg1
--- Volume groups ---
VG Name                /dev/vg1
VG Write Access        read/write
VG Status               available
Max LV                 255
Cur LV                 0
Open LV                 0
Max PV                 16
Cur PV                 1
Act PV                 1
Max PE per PV         25535
VGDA                   2
PE Size (Mbytes)       4
Total PE             17500
Alloc PE                12799
Free PE                 4701
Total PVG               0
Total Spare PVs         0
Total Spare PVs in use  0
VG Version              1.0
VG Max Size             1634240m
VG Max Extents          408560
```

The amount of disk space increased by the number of physical extents allocated on the disk from 12799 to 17500.

Performing online DLE when some additional disk space can be allocated

This example assumes you have a 50 GB disk belonging to volume group `vg1` that has its `max_PE` per PV value set to 13900. The disk size was increased to 68 GB using the relevant disk utilities.

1. Review current volume group parameters.

```
# vgsdisplay vg1
--- Volume groups ---
VG Name                /dev/vg1
VG Write Access        read/write
VG Status               available
Max LV                 255
Cur LV                 1
Open LV                 0
Max PV                 16
Cur PV                 1
Act PV                 1
Max PE per PV         13900
VGDA                   2
PE Size (Mbytes)       4
Total PE             12799
Alloc PE                12799
Free PE                 0
Total PVG               0
Total Spare PVs         0
```

```

Total Spare PVs in use      0
VG Version                  1.0
VG Max Size                 889600m
VG Max Extents              222400

```

There are 12799 extents allocated on this physical volume.

2. Use online `vgmodify` to review the effect of the change in disk size.

```

# vgmodify -r -a -E vg1
"/dev/rdisk/disk43" size changed from 52428800 to 71687369kb
"/dev/rdisk/disk43" size is limited by the maximum extents per PV
to 56934400.

```

```

An update to the Volume Group IS required
Review complete. Volume group not modified

```

3. Use online `vgmodify` to change the disk size.

```

# vgmodify -a -E vg1
"/dev/rdisk/disk43" size changed from 52428800 to 71687369kb
"/dev/rdisk/disk43" size is limited by the maximum extents per PV
to 56934400.

```

4. Verify the change.

```

# vgdisplay vg1
--- Volume groups ---
VG Name                /dev/vg1
VG Write Access        read/write
VG Status               available
Max LV                 255
Cur LV                 1
Open LV                 0
Max PV                  16
Cur PV                 1
Act PV                  1
Max PE per PV          13900
VGDA                    2
PE Size (Mbytes)       4
Total PE              13900
Alloc PE                12799
Free PE                 1101
Total PVG                0
Total Spare PVs         0
Total Spare PVs in use  0
VG Version              1.0
VG Max Size             889600m
VG Max Extents          222400

```

The entire increase in disk space is not made available for use by LVM. This is because of the `max_PE` value, which is set to 13900. Only part of the disk space (54 GB out of 68 GB) was used to increase the number of physical extents allocated on the disk from 12799 to 13900. To fully utilize the 68 GB disk space, you must use offline `vgmodify` and modify the volume group configuration parameters.

Performing online DLE when none of the additional disk space can be allocated

This example assumes you have a 50 GB disk belonging to volume group `vg1` that has its `max_PE` per PV value set to 12799. The disk size was increased to 63 GB using the relevant disk utilities.

1. Review current volume group parameters.

```

# vgdisplay vg1
--- Volume groups ---

```

```

VG Name                /dev/vg1
VG Write Access        read/write
VG Status              available
Max LV                 255
Cur LV                1
Open LV                0
Max PV                 16
Cur PV                1
Act PV                 1
Max PE per PV        12799
VGDA                   2
PE Size (Mbytes)      4
Total PE           12799
Alloc PE               12799
Free PE                0
Total PVG              0
Total Spare PVs        0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size            819136m
VG Max Extents         204784

```

There are 12799 extents allocated on this physical volume.

2. Use online `vgmodify` to review the change in disk size.

```

# vgmodify -r -a -E vg1
An update to the Volume Group is NOT required
Review complete. Volume group not modified

```

The output indicates that the volume group does not require an update. This is because the number of extents allocated on the PV is already at the `max_PE` value of 12799; you cannot add more extents to this PV without changing the `max_PE` value. To change the `max_PE` value, you must use offline `vgmodify` (see the examples on physical extent renumbering).

Offline DLE examples

The following example assumes the volume group is already activated. This is not a requirement as `vgmodify` activates the volume group if needed. If `vgmodify` does activate the volume group, it deactivates it before completion.

Performing DLE when only some disk space can be allocated

1. Run `vgmodify -v -r vname`. Any disks that were resized since `pvcreate` was run on them are reported as follows:

```
/dev/rdisk/c0t0d0 size changed from 16777216 to 100000000kb
```

If there is insufficient space to allocate all the disk space on any device, a message similar to the following appears:

```

/dev/rdisk/c0t4d2 Warning: Max_PE_per_PV for the volume group (4348)
too small for this PV (24413).
Using only 4348 PEs from this physical volume.

```

If you want to change the volume group configuration parameters, follow the guidelines in the [Volume group configuration changes](#) section.

2. During a maintenance window, deactivate the volume group.
3. Use `vgmodify` to review the configuration.

```
# vgmodify -r -v vg04
```

Volume Group configuration for /dev/vg04 has been saved in /etc/lvmconf/vg04.conf

Current Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	1023
PE Size (Mbytes)	4
VGRA Size (Kbytes)	208

/dev/rdisk/c5t0d0 Warning: Max_PE_per_PV for the volume group (1023) too small for this PV (1464).

Using only 1023 PEs from this physical volume.

/dev/rdisk/c6t0d0 Warning: Max_PE_per_PV for the volume group (1023) too small for this PV (1220).

Using only 1023 PEs from this physical volume.

"/dev/rdisk/c5t0d0" size changed from 4194304 to 6000000kb
An update to the Volume Group IS required

New Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	1023
PE Size (Mbytes)	4
VGRA Size (Kbytes)	208

Review complete. Volume group not modified

c5t0d0 increased in size since it was initialized with pvcreate. LVM knows the correct size of c6t0d0 so it was not changed since it was initialized with pvcreate. Both disks are unable to allocate all their space as the maximum number of PEs per PV setting is too low. A setting of 1464 can accommodate the largest disk currently in the volume group (c5t0d0).

4. Use vgmodify in table mode and review suitable configurations.

```
# vgmodify -t -v vg04
```

Volume Group configuration for /dev/vg04 has been saved in /etc/lvmconf/vg04.conf

Current Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	1023
PE Size (Mbytes)	4
VGRA Size (Kbytes)	208

VGRA space (Kbytes) on all Physical Volumes:

PV	current	-n
/dev/rdisk/c4t0d0	896	4096
/dev/rdisk/c5t0d0	896	4096
/dev/rdisk/c6t0d0	896	4096
Summary	896	4096

Volume Group optimized settings (no PEs renumbered):

max_pv(-p)	max_pe(-e)	Disk size (Mb)
3	35836	143345
4	26876	107505

* Entries deleted for brevity

20	5372	21489
21	5116	20465

* Entries deleted for brevity

60	1788	7153
70	1532	6129

* Entries deleted for brevity

- Review the configuration for a *max_pv* of 20. The *max_pv* values up to 70 provide for a sufficient number of *max_pes* for the current largest disk.

```
# vgmodify -r -p 20 -e 5372 -v vg04
```

Volume Group configuration for /dev/vg04 has been saved in /etc/lvmconf/vg04.conf

Current Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	1023
PE Size (Mbytes)	4
VGRA Size (Kbytes)	208

The current and new Volume Group parameters differ.

"/dev/rdisk/c5t0d0" size changed from 4194304 to 6000000kb

Physical Volume "/dev/rdisk/c6t0d0" the current and new settings differ

An update to the Volume Group IS required

New Volume Group settings:

Max LV	255
Max PV	20
Max PE per PV	5372
PE Size (Mbytes)	4
VGRA Size (Kbytes)	896

Review complete. Volume group not modified

- Deactivate the volume group in preparation for the modification.

```
# vgchange -a n vg04
```

Volume group "vg04" has been successfully changed.

- Use *vgmodify* in change mode to change the configuration.

```
# vgmodify -p 20 -e 5372 -v vg04
```

Performing "vgchange -a y -l -p -s vg04" to collect data

Activated volume group

Volume group "vg04" has been successfully activated.

Volume Group configuration for /dev/vg04 has been saved in

/etc/lvmconf/vg04.conf

Deactivating Volume Group "vg04"

Volume group "vg04" has been successfully deactivated.

Current Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	1023
PE Size (Mbytes)	4
VGRA Size (Kbytes)	208

The current and new Volume Group parameters differ.

"/dev/rdisk/c5t0d0" size changed from 4194304 to 6000000kb

Physical Volume "/dev/rdisk/c6t0d0" the current and new settings differ

An update to the Volume Group IS required

New Volume Group settings:

Max LV	255
Max PV	20
Max PE per PV	5372
PE Size (Mbytes)	4
VGRA Size (Kbytes)	896

```

New Volume Group configuration for "vg04" has been saved in
"/etc/lvmconf/vg04.conf"
Old Volume Group configuration for "vg04" has been saved in
"/etc/lvmconf/vg04.conf.old"
Starting the modification by writing to all Physical Volumes
Applying the configuration to all Physical Volumes from
"/etc/lvmconf/vg04.conf"
Volume Group configuration has been restored to /dev/rdisk/c4t0d0
Volume Group configuration has been restored to /dev/rdisk/c5t0d0
Volume Group configuration has been restored to /dev/rdisk/c6t0d0
Completed the modification process.
New Volume Group configuration for "vg04" has been saved in
"/etc/lvmconf/vg04.conf.old"
Volume group "vg04" has been successfully changed.

```

8. Activate the volume group.

```

# vgchange -a y -s vg04
Activated volume group
Volume group "vg04" has been successfully changed.

```

9. Verify the changes.

```

# vgdisplay vg04
--- Volume groups ---
VG Name                /dev/vg04
VG Write Access        read/write
VG Status              available
Max LV                 255
Cur LV                0
Open LV               11
Max PV                20
Cur PV                3
Act PV                3
Max PE per PV       5372
VGDA                  6
PE Size (Mbytes)      4
Total PE              3707
Alloc PE              0
Free PE               3707
Total PVG             0
Total Spare PVs      0
Total Spare PVs in use 0
VG Version            1.0
VG Max Size           429760m
VG Max Extents        107440

```

```

# pvdisplay /dev/dsk/c5t0d0

```

```

--- Physical volumes ---
PV Name                /dev/dsk/c5t0d0
VG Name                /dev/vg04
PV Status              available
Allocatable           yes
VGDA                  2
Cur LV                0
PE Size (Mbytes)      4
Total PE              1464
Free PE               1464
Allocated PE          0
Stale PE              0
IO Timeout (Seconds)  default
Autoswitch            On
Proactive Polling     On

```

The Total PE is now 1464, which is greater than the previous *max_pe* setting of 1023.

```

# pvdiskdisplay /dev/dsk/c6t0d0
--- Physical volumes ---
PV Name                /dev/dsk/c6t0d0
VG Name                /dev/vg04
PV Status              available
Allocatable           yes
VGDA                  2
Cur LV                0
PE Size (Mbytes)      4
Total PE            1220
Free PE                1220
Allocated PE           0
Stale PE              0
IO Timeout (Seconds)  default
Autoswitch             On
Proactive Polling     On

```

The Total PE is now 1220.

Online and offline DLC examples

The examples in this section are the same for both online and offline, and assume the volume group is already activated. In offline mode, this is not a requirement, as `vgmodify` activates the volume group if needed. If `vgmodify` does activate the volume group, it deactivates it before completion.

Also, in offline mode, the volume group can be active for review mode, but must be deactivated during the actual `vgmodify` operation. In online mode, the volume group must be active during the actual operation.

Performing DLC on a physical volume with free extents

This example assumes a volume group that has a disk of size 73 GB, and you want to determine if you can contract the physical volume can to 50 GB from the LVM end.

1. Review the current configuration.

```

# vgsdisplay vg01
--- Volume groups ---
VG Name                /dev/vg01
VG Write Access        read/write
VG Status              available
Max LV                 255
Cur LV                1
Open LV                1
Max PV                 16
Cur PV                1
Act PV                 1
Max PE per PV         17501
VGDA                  2
PE Size (Mbytes)      4
Total PE               17501
Alloc PE               10000
Free PE                7501
Total PVG              0
Total Spare PVs        0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size            1120064m
VG Max Extents         280016

# pvdiskdisplay -v /dev/dsk/c4t2d0
--- Physical volumes ---
PV Name                /dev/dsk/c4t2d0

```

```

VG Name                /dev/vg01
PV Status              available
Allocatable            yes
VGDA                   2
Cur LV                1
PE Size (Mbytes)      4
Total PE               17501
Free PE                7501
Allocated PE           10000
Stale PE               0
IO Timeout (Seconds)  default
Autoswitch             On
Proactive Polling      On

```

--- Distribution of physical volume ---

```

LV Name                LE of LV  PE for LV
/dev/vg01/lvol1       10000    10000

```

--- Physical extents ---

```

PE    Status  LV                LE
00000 current  /dev/vg01/lvol1  00000
00001 current  /dev/vg01/lvol1  00001
00002 current  /dev/vg01/lvol1  00002
00003 current  /dev/vg01/lvol1  00003
00004 current  /dev/vg01/lvol1  00004
00005 current  /dev/vg01/lvol1  00005
*Entries deleted for brevity*
09994 current  /dev/vg01/lvol1  09994
09995 current  /dev/vg01/lvol1  09995
09996 current  /dev/vg01/lvol1  09996
09997 current  /dev/vg01/lvol1  09997
09998 current  /dev/vg01/lvol1  09998
09999 current  /dev/vg01/lvol1  09999
10000 free
10001 free
10002 free
*Entries deleted for brevity*
17496 free
17497 free
17498 free
17499 free
17500 free

```

diskinfo /dev/rdisk/c4t2d0

```

SCSI describe of /dev/rdisk/c4t2d0:
    vendor: HP 73.4G
    product id: ST373405FC
    type: direct access
    size: 71687369 Kbytes
    bytes per sector: 512

```

Out of 17501 extents on the disk /dev/rdisk/c4t2d0, the first 10,000 extents are allocated; the rest of the extents are free.

2. Run the `vgmodify` command with the `-C` option in review mode to determine if you can reduce the physical volume size to 50 GB. Note: You can run review mode with and without the `-a` option. The `-a` option indicates that the `vgmodify` command can be run when the volume group is active (online `vgmodify`).

```
# vgmodify -r -C 51200m vg01 /dev/rdisk/c4t2d0 #Offline Mode
or
```

```
# vgmodify -a -r -C 51200m vg01 /dev/rdisk/c4t2d0 #Online mode
```

The physical volume `"/dev/rdisk/c4t2d0"` is ready to be prepared for contraction to 51200 MB.
 The physical volume `"/dev/rdisk/c4t2d0"` can be prepared for contraction to 40003 MB without having to move any physical extents on it.
 The physical volume `"/dev/rdisk/c4t2d0"` can be prepared for contraction to a minimum size of 40003 MB after freeing up the last 7501 physical extents.
 An update to the Volume Group IS required
 Review complete. Volume group not modified

Note: You can prepare the physical volume for the DLC operation without having to move any physical extents on it.

3. Perform the actual operation in change mode. For offline `vgmodify`, deactivate the volume group before performing this operation.

```
# vgchange -a n vg01          # For offline mode only
Volume group "vg01" has been successfully changed.
```

Run `vgmodify` without the `-a` option.

```
# vgmodify -C 51200m vg01 /dev/rdisk/c4t2d0 #offline mode
```

For online `vgmodify`, enter the following:

```
# vgmodify -a -C 51200m vg01 /dev/rdisk/c4t2d0 # online mode
```

The output for either command is as follows:

```
"/dev/rdisk/c4t2d0" size changed from 71687369 to 52428800kb
Volume Group configuration for /dev/vg01 has been saved in
/etc/lvmconf/vg01.conf
```

For offline mode, activate the volume group after the actual DLC operation.

```
# vgchange -a y vg01      # offline mode only
Activated volume group
Volume group "vg01" has been successfully changed.
```

4. Verify the results.

```
# vgsdisplay vg01
--- Volume groups ---
VG Name                /dev/vg01
VG Write Access        read/write
VG Status               available
Max LV                 255
Cur LV                1
Open LV                1
Max PV                 16
Cur PV                1
Act PV                1
Max PE per PV         17501
VGDA                   2
PE Size (Mbytes)      4
Total PE              12799
Alloc PE              10000
Free PE              2799
Total PVG             0
Total Spare PVs       0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size           1120064m
VG Max Extents        280016
```

```
# pvdisplay /dev/dsk/c4t2d0
--- Physical volumes ---
```

```

PV Name                /dev/dsk/c4t2d0
VG Name                /dev/vg01
PV Status              available
Allocatable            yes
VGDA                   2
Cur LV                1
PE Size (Mbytes)      4
Total PE             12799
Free PE                2799
Allocated PE           10000
Stale PE               0
IO Timeout (Seconds)  default
Autoswitch             On
Proactive Polling      On

```

After the DLC operation, Total PE is reduced from 17501 to 12799 and Free PE on the volume group is reduced from 7501 to 2799.

Performing DLC on a physical volume with allocated extents

This example assumes a volume group that has a disk of size 73 GB, and you want to determine if you can contract the physical volume can to 50 GB from the LVM end.

1. Review the current configuration.

```

# vgsdisplay -v vg01
--- Volume groups ---
VG Name                /dev/vg01
VG Write Access        read/write
VG Status              available
Max LV                 255
Cur LV                1
Open LV                1
Max PV                 16
Cur PV                2
Act PV                 2
Max PE per PV          17501
VGDA                   4
PE Size (Mbytes)      4
Total PE               35002
Alloc PE               14000
Free PE                21002
Total PVG              0
Total Spare PVs        0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size            1120064m
VG Max Extents         280016

# pvdisplay -v /dev/dsk/c4t2d0
--- Physical volumes ---
PV Name                /dev/dsk/c4t2d0
VG Name                /dev/vg01
PV Status              available
Allocatable            yes
VGDA                   2
Cur LV                1
PE Size (Mbytes)      4
Total PE               17501
Free PE                3501
Allocated PE           14000
Stale PE               0
IO Timeout (Seconds)  default
Autoswitch             On

```

Proactive Polling On

```
--- Distribution of physical volume ---
LV Name                    LE of LV    PE for LV
/dev/vg01/lvol1            14000       14000

--- Physical extents ---
PE     Status    LV                    LE
00000 current    /dev/vg01/lvol1       00000
00001 current    /dev/vg01/lvol1       00001
00002 current    /dev/vg01/lvol1       00002
00003 current    /dev/vg01/lvol1       00003
00004 current    /dev/vg01/lvol1       00004
00005 current    /dev/vg01/lvol1       00005
*Entries deleted for brevity*
13996 current    /dev/vg01/lvol1       13996
13997 current    /dev/vg01/lvol1       13997
13998 current    /dev/vg01/lvol1       13998
13999 current    /dev/vg01/lvol1       13999
14000 free                                           00000
14001 free                                           00000
14002 free                                           00000
*Entries deleted for brevity*
17496 free                                           00000
17497 free                                           00000
17498 free                                           00000
17499 free                                           00000
17500 free                                           00000
```

pvdisplay /dev/dsk/c4t1d0

```
--- Physical volumes ---
PV Name                    /dev/dsk/c4t1d0
VG Name                    /dev/vg01
PV Status                   available
Allocatable                yes
VGDA                       2
Cur LV                    0
PE Size (Mbytes)           4
Total PE                   17501
Free PE                    17501
Allocated PE               0
Stale PE                   0
IO Timeout (Seconds)       default
Autoswitch                 On
Proactive Polling           On
```

diskinfo /dev/rdisk/c4t2d0

```
SCSI describe of /dev/rdisk/c4t2d0:
      vendor: HP 73.4G
      product id: ST373405FC
      type: direct access
      size: 71687369 Kbytes
      bytes per sector: 512
```

2. Run the `vgmodify` command with the `-C` option in review mode to determine if you can reduce the physical volume size to 50 GB. Note: You can run review mode with and without the `-a` option. The `-a` option indicates that the `vgmodify` command can be run when the volume group is active (online `vgmodify`).

```
# vgmodify -r -C 51200 vg01 /dev/rdisk/c4t2d0        # offline mode
or
```

```
# vgmodify -a -r -C 51200 vg01 /dev/rdisk/c4t2d0 #online mode
The last 4702 extent(s) on the physical volume "/dev/rdisk/c4t2d0"
have to be made free (see pvmove(1M)) to be able to prepare it for
contraction to 51200 MB.
The physical volume "/dev/rdisk/c4t2d0" can be prepared for
contraction to 56003 MB without having to move any physical extents
on it.
The physical volume "/dev/rdisk/c4t2d0" can be prepared for
contraction to a minimum size of 56003 MB after freeing up the last
3501 physical extents .
An update to the Volume Group IS required
Review complete. Volume group not modified
The output shows the minimum size to which the physical volume can be contracted without
having to move any physical extents on it.
```

- Use the pvmove command to move the allocated extents. To reduce the size of the disk /dev/dsk/c4t2d0 to 50 GB, out of the 14000 allocated extents, you must move the last 1201 of the allocated extents to a different disk. In other words, the total number of allocated extents on disk /dev/dsk/c4t2d0 must be 12799.

Preview the pvmove operation.

```
# pvmove -p /dev/dsk/c4t2d0:12799-14000 /dev/dsk/c4t1d0
```

```
--- Preview of the Relocation Operation ---
Source PV      Source PE  Destination PV Destination PE
/dev/dsk/c4t2d0 12798    /dev/dsk/c4t1d0      0
/dev/dsk/c4t2d0 12799    /dev/dsk/c4t1d0      1
/dev/dsk/c4t2d0 12800    /dev/dsk/c4t1d0      2
/dev/dsk/c4t2d0 12801    /dev/dsk/c4t1d0      3
/dev/dsk/c4t2d0 12802    /dev/dsk/c4t1d0      4
* Entries deleted for brevity *
/dev/dsk/c4t2d0 13996    /dev/dsk/c4t1d0     1197
/dev/dsk/c4t2d0 13997    /dev/dsk/c4t1d0     1198
/dev/dsk/c4t2d0 13998    /dev/dsk/c4t1d0     1199
/dev/dsk/c4t2d0 13999    /dev/dsk/c4t1d0     1200
```

Perform the actual pvmove operation.

```
# pvmove /dev/dsk/c4t2d0:12799-14000 /dev/dsk/c4t1d0
Transferring logical extents of logical volume "/dev/vg01/lvol1"...
Physical volume "/dev/dsk/c4t2d0" has been successfully moved.
Volume Group configuration for /dev/vg01 has been saved in
/etc/lvmconf/vg01.conf
```

- Verify the pvmove operation.

```
# pvdisplay /dev/dsk/c4t2d0
```

```
--- Physical volumes ---
PV Name                /dev/dsk/c4t2d0
VG Name                /dev/vg01
PV Status              available
Allocatable            yes
VGDA                   2
Cur LV                1
PE Size (Mbytes)      4
Total PE               17501
Free PE                4702
Allocated PE          12799
Stale PE               0
IO Timeout (Seconds)  default
Autoswitch             On
Proactive Polling     On
```

```
# pvdisplay /dev/dsk/c4t1d0
```

```
--- Physical volumes ---
```

```

PV Name                /dev/dsk/c4t1d0
VG Name                /dev/vg01
PV Status              available
Allocatable            yes
VGDA                   2
Cur LV                1
PE Size (Mbytes)      4
Total PE               17501
Free PE                16300
Allocated PE          1201
Stale PE               0
IO Timeout (Seconds)  default
Autoswitch             On
Proactive Polling      On

```

The last 1201 extents were moved from physical volume /dev/dsk/c4t2d0 to /dev/dsk/c4t1d0.

- Run vgmodify in review mode.

```

# vgmodify -r -C 51200 vg01 /dev/rdisk/c4t2d0 # Offline mode
or

```

```

# vgmodify -a -r -C 51200 vg01 /dev/rdisk/c4t2d0 #Online mode
The physical volume "/dev/rdisk/c4t2d0" is ready to be prepared for
contraction to 51200 MB.
The physical volume "/dev/rdisk/c4t2d0" can be prepared for
contraction to 51199 MB without having to move any physical extents
on it.
The physical volume "/dev/rdisk/c4t2d0" can be prepared for
contraction to a minimum size of 51199 MB after freeing up the last
4702 physical extents .
An update to the Volume Group IS required
Review complete. Volume group not modified

```

The physical volume is ready to be prepared for DLC.

- Perform the actual operation in change mode.

For offline vgmodify, deactivate the volume group before performing this operation.

```

# vgchange -a n vg01 # For offline mode only
Volume group "vg01" has been successfully changed.

```

```

# vgmodify -C 51200 vg01 /dev/rdisk/c4t2d0 #Offline mode
or
# vgmodify -a -C 51200 vg01 /dev/rdisk/c4t2d0 #Online mode
"/dev/rdisk/c4t2d0" size changed from 71687369 to 52428800kb
Volume Group configuration for /dev/vg01 has been saved in
/etc/lvmconf/vg01.conf

```

For offline mode, activate the volume group after the actual DLC operation.

```

# vgchange -a y vg01 # Offline mode only
Activated volume group
Volume group "vg01" has been successfully changed.

```

- Verify the results.

```

# vgdisplay vg01
--- Volume groups ---
VG Name                /dev/vg01
VG Write Access         read/write
VG Status               available
Max LV                 255
Cur LV                 1

```

```

Open LV                1
Max PV                 16
Cur PV                2
Act PV                 2
Max PE per PV         17501
VGDA                   4
PE Size (Mbytes)      4
Total PE               30300
Alloc PE               14000
Free PE                16300
Total PVG              0
Total Spare PVs        0
Total Spare PVs in use 0
VG Version              1.0
VG Max Size            1120064m
VG Max Extents         280016

```

```
# pvdisplay /dev/dsk/c4t2d0
```

```

--- Physical volumes ---
PV Name                 /dev/dsk/c4t2d0
VG Name                 /dev/vg01
PV Status                available
Allocatable              yes
VGDA                     2
Cur LV                  1
PE Size (Mbytes)        4
Total PE              12799
Free PE                  0
Allocated PE             12799
Stale PE                 0
IO Timeout (Seconds)    default
Autoswitch                On
Proactive Polling        On

```

After the DLC operation, Total PE is reduced from 17501 to 12799.

Performing DLC on a physical volume that has holes

This example assumes a volume group that has a 73 GB disk with the first initial extents allocated and the last few extents allocated. You want to determine if the physical volume size can be contracted to 50 GB from the LVM end.

1. Review the current configuration.

```

# vgdisplay -v vg01
--- Volume groups ---
VG Name                 /dev/vg01
VG Write Access          read/write
VG Status                available
Max LV                  255
Cur LV                  2
Open LV                  2
Max PV                   16
Cur PV                  2
Act PV                   2
Max PE per PV           17501
VGDA                     4
PE Size (Mbytes)        4
Total PE                 35002
Alloc PE                 14000
Free PE                  21002
Total PVG                 0
Total Spare PVs           0
Total Spare PVs in use   0

```

```

VG Version          1.0
VG Max Size        1120064m
VG Max Extents     280016

```

```

--- Logical volumes ---

```

```

LV Name             /dev/vg01/lvol1
LV Status           available/syncd
LV Size (Mbytes)    48000
Current LE          12000
Allocated PE        12000
Used PV             1

```

```

LV Name             /dev/vg01/lvol2
LV Status           available/syncd
LV Size (Mbytes)    8000
Current LE          2000
Allocated PE        2000
Used PV             1

```

```

--- Physical volumes ---

```

```

PV Name             /dev/dsk/c4t2d0
PV Status           available
Total PE            17501
Free PE             3501
Autoswitch          On
Proactive Polling   On

```

```

PV Name             /dev/dsk/c4t1d0
PV Status           available
Total PE            17501
Free PE             17501
Autoswitch          On
Proactive Polling   On

```

```

# pvdisplay -v /dev/dsk/c4t2d0

```

```

--- Physical volumes ---

```

```

PV Name             /dev/dsk/c4t2d0
VG Name             /dev/vg01
PV Status           available
Allocatable         yes
VGDA                2
Cur LV             2
PE Size (Mbytes)    4
Total PE            17501
Free PE             3501
Allocated PE        14000
Stale PE            0
IO Timeout (Seconds) default
Autoswitch          On
Proactive Polling   On

```

```

--- Distribution of physical volume ---

```

```

LV Name             LE of LV  PE for LV
/dev/vg01/lvol1    12000    12000
/dev/vg01/lvol2    2000     2000

```

```

--- Physical extents ---

```

```

PE    Status  LV                      LE
00000 current  /dev/vg01/lvol1        00000
00001 current  /dev/vg01/lvol1        00001
00002 current  /dev/vg01/lvol1        00002
00003 current  /dev/vg01/lvol1        00003

```

```

*Entries deleted for brevity*
 11997 current /dev/vg01/lvol1 11997
 11998 current /dev/vg01/lvol1 11998
 11999 current /dev/vg01/lvol1 11999
 12000 free 00000
 12001 free 00000

*Entries deleted for brevity*
 13998 free 00000
 13999 free 00000
 14000 current /dev/vg01/lvol2 00000
 14001 current /dev/vg01/lvol2 00001
 14002 current /dev/vg01/lvol2 00002

*Entries deleted for brevity*
 15997 current /dev/vg01/lvol2 01997
 15998 current /dev/vg01/lvol2 01998
 15999 current /dev/vg01/lvol2 01999
 16000 free 00000
 16001 free 00000

*Entries deleted for brevity*
 17498 free 00000
 17499 free 00000
 17500 free 00000

```

```

# diskinfo /dev/rdisk/c4t2d0
SCSI describe of /dev/rdisk/c4t2d0:
    vendor: HP 73.4G
    product id: ST373405FC
    type: direct access
    size: 71687369 Kbytes
    bytes per sector: 512

```

On disk /dev/dsk/c4t2d0, the first 12000 extents belong to /dev/vg01/lvol1 and the next 2000 extents are free. Extents from 14000 to 15999 are allocated and belong to logical volume /dev/vg01/lvol2.

2. Run the `vgmodify` command with the `-C` option in review mode to determine if you can reduce the physical volume size to 50 GB. Note: You can run review mode with and without the `-a` option. The `-a` option indicates that the `vgmodify` command can be run when the volume group is active (online `vgmodify`).

```

# vgmodify -r -C 51200 vg01 /dev/rdisk/c4t2d0
The last 4702 extent(s) on the physical volume "/dev/rdisk/c4t2d0"
have to be made free (see pvmove(1M)) to be able to prepare it for
contraction to 51200 MB.
The physical volume "/dev/rdisk/c4t2d0" can be prepared for
contraction to 64003 MB without having to move any physical extents
on it.
The physical volume "/dev/rdisk/c4t2d0" can be prepared for
contraction to a minimum size of 56003 MB after freeing up the last
3501 physical extents.
An update to the Volume Group IS required
Review complete. Volume group not modified

```

In the output, the second message shows the minimum size to which the physical volume can be contracted without having to move any physical extents on it. The third message shows the minimum size to which the physical volume can be contracted after moving the allocated extents.

3. Use the `pvmove` command to move the allocated physical extents. To reduce the size of the disk to 50 GB, you must move the allocated extents of /dev/vg01/lvol2 to a different disk.

Preview the pvmove operation.

```
# pvmove -p -n /dev/vg01/lvol2 /dev/dsk/c4t2d0 /dev/dsk/c4t1d0
--- Preview of the Relocation Operation ---
Source PV          Source PE  Destination PV  Destination PE
/dev/dsk/c4t2d0    14000     /dev/dsk/c4t1d0  0
/dev/dsk/c4t2d0    14001     /dev/dsk/c4t1d0  1
/dev/dsk/c4t2d0    14002     /dev/dsk/c4t1d0  2
/dev/dsk/c4t2d0    14003     /dev/dsk/c4t1d0  3
/dev/dsk/c4t2d0    14004     /dev/dsk/c4t1d0  4
/dev/dsk/c4t2d0    14005     /dev/dsk/c4t1d0  5
/dev/dsk/c4t2d0    14006     /dev/dsk/c4t1d0  6
/dev/dsk/c4t2d0    14007     /dev/dsk/c4t1d0  7
*Entries deleted for brevity
/dev/dsk/c4t2d0    15994     /dev/dsk/c4t1d0  1994
/dev/dsk/c4t2d0    15995     /dev/dsk/c4t1d0  1995
/dev/dsk/c4t2d0    15996     /dev/dsk/c4t1d0  1996
/dev/dsk/c4t2d0    15997     /dev/dsk/c4t1d0  1997
/dev/dsk/c4t2d0    15998     /dev/dsk/c4t1d0  1998
/dev/dsk/c4t2d0    15999     /dev/dsk/c4t1d0  1999
```

Perform the actual pvmove operation.

```
# pvmove -n /dev/vg01/lvol2 /dev/dsk/c4t2d0 /dev/dsk/c4t1d0
Transferring logical extents of logical volume "/dev/vg01/lvol2"...
Physical volume "/dev/dsk/c4t2d0" has been successfully moved.
Volume Group configuration for /dev/vg01 has been saved in
/etc/lvmconf/vg01.conf
```

4. Verify the results of the pvmove operation.

```
# pvdisplay /dev/dsk/c4t2d0
--- Physical volumes ---
PV Name                /dev/dsk/c4t2d0
VG Name                /dev/vg01
PV Status              available
Allocatable           yes
VGDA                  2
Cur LV                1
PE Size (Mbytes)      4
Total PE              17501
Free PE               5501
Allocated PE          12000
Stale PE              0
IO Timeout (Seconds)  default
Autoswitch            On
Proactive Polling     On
```

```
# pvdisplay /dev/dsk/c4t1d0
--- Physical volumes ---
PV Name                /dev/dsk/c4t1d0
VG Name                /dev/vg01
PV Status              available
Allocatable           yes
VGDA                  2
Cur LV                1
PE Size (Mbytes)      4
Total PE              17501
Free PE               15501
Allocated PE          2000
Stale PE              0
IO Timeout (Seconds)  default
Autoswitch            On
Proactive Polling     On
```

The allocated extents on physical volume /dev/dsk/c4t2d0 were moved to /dev/dsk/c4t1d0.

5. Run vgmodify in review mode.

```
# vgmodify -r -C 51200 vg01 /dev/rdisk/c4t2d0
The physical volume "/dev/rdisk/c4t2d0" is ready to be prepared for
contraction to 51200 MB.
The physical volume "/dev/rdisk/c4t2d0" can be prepared for
contraction to 48003 MB without having to move any physical extents
on it.
The physical volume "/dev/rdisk/c4t2d0" can be prepared for
contraction to a minimum size of 48003 MB after freeing up the last
5501 physical extents .
An update to the Volume Group IS required
Review complete. Volume group not modified
```

The last 5501 physical extents are now free because there was a hole before lvol2. By moving lvol2, you can now perform the DLC.

6. Perform the LUN contraction.

For offline vgmodify, deactivate the volume group before performing the actual operation and run the vgmodify command without -a option.

```
# vgchange -a n vg01 # For offline mode only
Volume group "vg01" has been successfully changed.

# vgmodify -C 51200 vg01 /dev/rdisk/c4t2d0 #Offline mode
or
# vgmodify -a -C 51200 vg01 /dev/rdisk/c4t2d0 #Online mode
"/dev/rdisk/c4t2d0" size changed from 71687369 to 52428800kb
Volume Group configuration for /dev/vg01 has been saved in
/etc/lvmconf/vg01.conf
```

For offline vgmodify, activate the volume group.

```
# vgchange -a y vg01 # Offline mode only
Activated volume group
Volume group "vg01" has been successfully changed.
```

7. Verify the results of the DLC operation.

```
# pvdisplay /dev/dsk/c4t2d0
--- Physical volumes ---
PV Name                /dev/dsk/c4t2d0
VG Name                /dev/vg01
PV Status              available
Allocatable           yes
VGDA                   2
Cur LV                1
PE Size (Mbytes)      4
Total PE               12799
Free PE                799
Allocated PE           12000
Stale PE               0
IO Timeout (Seconds)  default
Autoswitch             On
Proactive Polling      On
```

After the DLC operation, Total PE is reduced from 17501 to 12799.

Online and offline volume group configuration change examples

The examples in this section are for both online and offline, and assume the volume group is already activated. In offline mode, this is not a requirement as `vgmodify` activates the volume group, if needed. If `vgmodify` activates the volume group, it deactivates it before completion.

In offline mode, the volume group can be active in case of review mode, but must be activated during the actual `vgmodify` operation. In online mode, the volume group must be active during the actual operation.

Increasing the maximum number of physical volumes and accommodating larger disks – without PE renumbering

Using `vgmodify -t`, select the entry from the tables that meets the requirement for the maximum disk size with an adequate number of physical volumes. If you cannot achieve the number of physical volumes you require, use the `vgmodify -tn` option. If you use a setting from the `-tn` table and this requires physical extent renumbering lower, run `vgmodify -tnv` and check that no disks need the first physical extent to be made free. If they do, free up this extent on each disk using `pvmove`, `lvreduce`, or `lvremove`. Run `vgmodify -r -e max_pe -p max_pv vgroupname`, where `max_pe` and `max_pv` are the chosen values. Finally, when a maintenance window is available, deactivate the volume group and run `vgmodify` with the same options as before but without `-r`.

This example assumes you want to place a disk that is 23 GB in size and increase the number of physical volumes to at least 19.

1. Review the current configuration

```
# vgmodify -tv vg02
Volume Group configuration for /dev/vg02 has been saved in
/etc/lvmconf/vg02.conf
```

Current Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	736

VGRA space (Kbytes) on all Physical Volumes:

PV	current	-n
/dev/rdisk/c0t0d0	896	4096
/dev/rdisk/c1t0d0	896	4096
Summary	896	4096

Volume Group optimized settings (no PEs renumbered):

max_pv(-p)	max_pe(-e)	Disk size (Mb)
2	53756	215025
3	35836	143345
4	26876	107505
* Entries deleted for brevity *		
17	6140	24561
18	5884	23537
19	5628	22513
20	5372	21489
21	5116	20465
22	4860	19441
* Entries deleted for brevity *		
141	632	2529

Table mode displays the current settings, including the current VGRA size. The `-v` argument shows the amount of space for the VGRA on each of the physical volumes. The summary

shows that you can increase the VGRA to 896 KB without using the `-n` argument or 4096 KB (the PE size) with `-n`. The list of settings is based upon a VGRA no greater than 896 KB in size.

2. Run `vgmodify` in review mode. There are two optimal settings that allow a 23 GB disk to be part of the volume group with at least 19 physical volumes. The following example uses a `max_pv` of 19.

```
# vgmodify -r -p 19 -e 5628 vg02 #offline mode
or
# vgmodify -r -a -p 19 -e 5628 vg02 # online mode
```

```
Volume Group configuration for /dev/vg02 has been saved in
/etc/lvmconf/vg02.conf
```

```
Current Volume Group settings:
```

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	736

```
The current and new Volume Group parameters differ.
An update to the Volume Group IS required
```

```
New Volume Group settings:
```

Max LV	255
Max PV	19
Max PE per PV	5628
PE Size (Mbytes)	4
VGRA Size (Kbytes)	896

```
Review complete. Volume group not modified
```

The review mode (`-r`) displays the current and new settings for comparison. The program completes before making any changes.

3. Apply the changes using the same `vgmodify` arguments but without `-r`.

For offline mode, deactivate the volume group and run `vgmodify` without the `-a` option.

```
# vgchange -a n vg02 # For offline mode only
Volume group "vg02" has been successfully changed.
```

```
# vgmodify -p 19 -e 5628 vg02 #Offline mode
or
# vgmodify -a -p 19 -e 5628 vg02 #Online mode
```

```
Current Volume Group settings:
```

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	896

```
The current and new Volume Group parameters differ.
An update to the Volume Group IS required
```

```
New Volume Group settings:
```

Max LV	255
Max PV	19
Max PE per PV	5628
PE Size (Mbytes)	4

```

New Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf"
Old Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf.old"
Starting the modification by writing to all Physical Volumes
Applying the configuration to all Physical Volumes from
"/etc/lvmconf/vg02.conf"
Volume Group configuration has been restored to /dev/rdisk/c0t0d0
Volume Group configuration has been restored to /dev/rdisk/c1t0d0
Completed the modification process.
New Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf.old"
Volume group "vg02" has been successfully changed.

```

Almost all the initial output is identical to that for `-r`. The underlined text is only applicable when a change is being made. Note the program reports whether the `VG.conf` or `VG.conf.old` contains the new or old layout at various stages (useful if it is interrupted).

4. For offline mode, activate the volume group.

```

# vgchange -a y vg02      # Offline mode only
Volume group "vg02" has been successfully changed.

```

5. Verify the results.

```

# vgdisplay vg02
--- Volume groups ---
VG Name                /dev/vg02
VG Write Access        read/write
VG Status               available
Max LV                 255
Cur LV                0
Open LV                0
Max PV                19
Cur PV                2
Act PV                 2
Max PE per PV       5628
VGDA                   4
PE Size (Mbytes)      4
Total PE               10238
Alloc PE               0
Free PE                10238
Total PVG              0
Total Spare PVs       0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size            429744m
VG Max Extents         106932

```

Note the Max PE per PV and Max PV settings match the requested setting.

Increasing the maximum number of physical volumes and accommodating larger disks – with PE renumbering

Using `vgmodify -t`, select the entry from the tables that meets the requirement for the maximum disk size with an adequate number of physical volumes. If you cannot achieve the number of physical volumes you require, use the `-tn` option on `vgmodify`. If you are using a setting from the `-tn` table and this requires physical extent renumbering lower, run `vgmodify -tnv` and check that no disks need the first physical extent to be made free. If they do, free up this extent on each disk using

pvmove, lvreduce, or lvremove. Run `vgmodify -r -e max_pe -p max_pv vgname`, where `max_pe` and `max_pv` are the chosen values. Finally, when a maintenance window is available, deactivate the volume group and run `vgmodify` with the same options as before but without `-r`.

This example assumes you want to place a disk that is 90 GB in size and increase the number of physical volumes to at least 20.

1. Verify the current configuration.

```
# vgmodify -tv vg01
```

```
Volume Group configuration for /dev/vg01 has been saved in
/etc/lvmconf/vg01.conf
```

```
Current Volume Group settings:
```

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	736

```
VGRA space (Kbytes) on Physical Volumes with extents in use:
```

PV	current	-n
/dev/rdisk/c0 t0d0	896	4096
/dev/rdisk/c0t1d0	896	4096
/dev/rdisk/c0t3d0	896	4096
Summary	896	4096

```
Volume Group optimized settings (no PEs renumbered):
```

max_pv(-p)	max_pe(-e)	Disk size (Mb)
3	35836	143345
4	26876	107505
5	21500	86001
6	17916	71665
7	15356	61425
* Entries deleted for brevity		
21	5116	56306
22	4860	19441
23	4604	18417
* Entries deleted for brevity		
105	1020	4081

Note without `-n` that we can only place 5 disks of the required size or greater into the volume group. Also that the summary shows that with `-n` you can handle a larger VGRA so using `-n` is beneficial.

```
# vgmodify -tnv vg01
```

```
Volume Group configuration for /dev/vg01 has been saved in
/etc/lvmconf/vg01.conf
```

```
Current Volume Group settings:
```

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	736

```
VGRA space (Kbytes) on Physical Volumes with extents in use:
```

PV	current	-n
/dev/rdisk/c0t0d0	896	4096
/dev/rdisk/c0t1d0	896	4096
/dev/rdisk/c0t3d0	896	4096

Physical Extent zero is not free on all PVs. You will not achieve these values until the first extent is made free (see `pvmove(1M)`) on all the following disks:

```
/dev/rdisk/c0t0d0
/dev/rdisk/c0t1d0
/dev/rdisk/c11t3d0
```

Volume Group optimized settings (PEs renumbered lower):

max_pv(-p)	max_pe(-e)	Disk size (Mb)
7	65535	262144
* Entries deleted for brevity		
19	26364	105460
20	25084	100340
21	23804	95220
22	22780	91124
23	21756	87028
24	20988	83956
* Entries deleted for brevity		
36	13820	55284

With `-n` we can place up to 23 disks of 90 GB in size, but we must free up the first extent on three disks. The need was for at least 20 disks so any entries between the 20 and 24 will suffice. The example uses 23.

- Free up the first extent on all four disks – note: keeping the extent on the same disk.

```
# pvmove /dev/dsk/c0t0d0:0 /dev/dsk/c0t0d0
```

```
Transferring logical extents of logical volume "/dev/vg02/lvol1"...
Physical volume "/dev/dsk/c0t0d0" has been successfully moved.
Volume Group configuration for /dev/vg02 has been saved in
/etc/lvmconf/vg02.conf
```

```
# pvmove /dev/dsk/c0t1d0:0 /dev/dsk/c0t1d0
```

```
Transferring logical extents of logical volume "/dev/vg02/lvol2"...
Physical volume "/dev/dsk/c0t1d0" has been successfully moved.
Volume Group configuration for /dev/vg02 has been saved in
/etc/lvmconf/vg02.conf
```

```
# pvmove /dev/dsk/c0t3d0:0 /dev/dsk/c0t3d0
```

```
Transferring logical extents of logical volume "/dev/vg02/lvol3"...
Physical volume "/dev/dsk/c0t3d0" has been successfully moved.
Volume Group configuration for /dev/vg02 has been saved in
/etc/lvmconf/vg02.conf
```

- Run `vgmodify` in review mode.

```
# vgmodify -r -n -p 23 -e 21756 vg02
```

```
Current Volume Group settings:
```

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	736

```
The current and new Volume Group parameters differ.
An update to the Volume Group IS required
```

```
New Volume Group settings:
```

Max LV	255
Max PV	23
Max PE per PV	21756

```
PE Size (Mbytes)      4
VGRA Size (Kbytes)   4064
```

Review complete. Volume group not modified

4. Run `vgmodify` in change mode.
For offline mode, deactivate the volume before performing the actual operation and run `vgmodify` without `-a` option..

```
# vgchange -a n vg02          # For offline mode only
Volume group "vg01" has been successfully changed.
```

```
# vgmodify -n -p 23 -e 21756 vg02  # Offline mode
or
# vgmodify -a -n -p 23 -e 21756 vg02  # Online mode
```

Current Volume Group settings:

```
Max LV      255
Max PV      16
Max PE per PV 5119
PE Size (Mbytes) 4
VGRA Size (Kbytes) 736
```

The current and new Volume Group parameters differ.
An update to the Volume Group IS required

New Volume Group settings:

```
Max LV      255
Max PV      23
Max PE per PV 21756
PE Size (Mbytes) 4
VGRA Size (Kbytes) 4064
```

New Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf"
Old Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf.old"
Starting the modification by writing to all Physical Volumes
Applying the configuration to all Physical Volumes from
"/etc/lvmconf/vg02.conf"
Completed the modification process.
New Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf.old"
Volume group "vg02" has been successfully changed.

For offline mode, activate the volume group.

```
# vgchange -a y vg02
Activated volume group
Volume group "vg02" has been successfully changed.
```

6. Verify the values are as requested.

```
# vgdisplay vg02
--- Volume groups ---
VG Name          /dev/vg02
VG Write Access  read/write
VG Status        available
Max LV           255
Cur LV          3
Open LV          3
Max PV           23
```

```

Cur PV          3
Act PV          3
Max PE per PV  21756
VGDA            6
PE Size (Mbytes) 4
Total PE        15354
Alloc PE        3000
Free PE         12354
Total PVG       0
Total Spare PVs 0
Total Spare PVs in use 0
VG Version      1.0
VG Max Size     2001552m
VG Max Extents  500388

```

The Max PV and Max PE per PV are as requested.

Optimizing the metadata space

Run `vgmodify` in review mode, with and without the `-a` option. The `-a` option enables the `vgmodify` command to run when the volume group is active (online `vgmodify`).

1.

```
# vgmodify -r -o vg02
```

Current Volume Group settings:

```

Max LV          255
Max PV          16
Max PE per PV   5119
PE Size (Mbytes) 4
VGRA Size (Kbytes) 736

```

New configuration requires `max_pes` are increased from 5119 to 6652
The current and new Volume Group parameters differ.
An update to the Volume Group IS required

New Volume Group settings:

```

Max LV          255
Max PV          16
Max PE per PV  6652
PE Size (Mbytes) 4
VGRA Size (Kbytes) 896

```

Review complete. Volume group not modified

Using `-o` increases the `max_pes` from 5119 to 6652 as the VGRA size is increased from 736 to 896KB.

2. Modify the volume group.

For offline mode, deactivate the volume group before performing the actual operation and run `vgmodify` command without the `-a` option.

```
# vgchange -a n vg02          # For offline mode only
Volume group "vg02" has been successfully changed.
```

```
# vgmodify -o vg02          # Offline mode
or
```

```
# vgmodify -a -o vg02      # Online mode
```

Current Volume Group settings:

```

Max LV          255
Max PV          16
Max PE per PV   5119
PE Size (Mbytes) 4

```

```

VGRA Size (Kbytes)      736
New configuration requires max_pes are increased from 5119 to 6652
The current and new Volume Group parameters differ.
An update to the Volume Group IS required

```

New Volume Group settings:

```

Max LV      255
Max PV      16
Max PE per PV 6652
PE Size (Mbytes) 4
VGRA Size (Kbytes) 896

```

```

New Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf"
Old Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf.old"
Starting the modification by writing to all Physical Volumes
Applying the configuration to all Physical Volumes from
"/etc/lvmconf/vg02.conf"
Completed the modification process.
New Volume Group configuration for "vg02" has been saved in
"/etc/lvmconf/vg02.conf.old"
Volume group "vg02" has been successfully changed.

```

For offline mode, activate the volume group after the actual operation.

```

# vgchange -a y vg02          # Offline mode only
Activated volume group
Volume group "vg02" has been successfully changed.

```

3. Verify the volume group.

```

# vgdisplay vg02
--- Volume groups ---
VG Name                /dev/vg02
VG Write Access        read/write
VG Status              available
Max LV                 255
Cur LV                3
Open LV                3
Max PV                 16
Cur PV                3
Act PV                 3
Max PE per PV        6652
VGDA                   6
PE Size (Mbytes)      4
Total PE               15357
Alloc PE               3000
Free PE                12357
Total PVG              0
Total Spare PVs       0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size            425728m
VG Max Extents         106432

```

The Max PE per PV is changed from 5119 to 6652.

Changing a bootable disk to non-bootable

To change a bootable disk to a non-bootable disk, follow these steps:

1. Run the following vgmodify commands:

```

vgmodify -B n -n -t vname <PV to convert> (with-n).
vgmodify -B n -t vname <PV to convert> (without -n).
vgmodify -B n -o -r vname <PV to convert>.

```

2. Select the entry from the output of the three commands that meets the requirements. If using a setting from the `-tn` table and this requires physical extent renumbering lower, run `vgmodify -B n -tnv vname <PV to convert>` and check that no disks need the first physical extent to be made free. If they do, free-up this extent on each disk using `pvmove`, `lvreduce`, or `lvremove`.
3. Run `vgmodify -B n -r -e max_pe -p max_pv vname <PV to convert>`, where `max_pe` and `max_pv` are the chosen values, to test the change.
4. When a maintenance window is available, deactivate the volume group and run `vgmodify` with the same options as before, but without `-r` or, if using the `-o` settings, `-B n -o vname <PV to convert>`.

Example

1. Run `vgmodify` in table mode and note any bootable disks reported.

```

# vgmodify -tv vg02
Volume Group configuration for /dev/vg02 has been saved in
/etc/lvmconf/vg02.conf

```

Current Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	736

VGRA space (Kbytes) on Physical Volumes with extents in use:

PV	current	-n
/dev/rdisk/c0t0d0	768	768
/dev/rdisk/c0t1d0	896	4096
/dev/rdisk/c0t3d0	896	4096
Summary	768	768

The space available for the configuration data will be limited by having bootable disks. If this is not a boot VG then consider changing the type, using `-B n`, of the following bootable disks:
/dev/rdisk/c1t0d0

Volume Group optimized settings (no PEs renumbered):

max_pv(-p)	max_pe(-e)	Disk size (Mb)
3	30460	121840
4	22780	91120
5	18172	72688
* Entries deleted for brevity		
39	2300	9200
44	2044	8176
45	1808	7232
* Entries deleted for brevity		
255	252	1008

The space for the VGRA on `c0t0d0` is 768 KB regardless of whether `-n` is used or not. This is expected for a bootable disk. Note how this affects the summary and is limiting both `-n` and non `-n` sizes.

- Run `vgmodify` in table mode with the bootable disk now made non-boot.

```
# vgmodify -tv -B n vg02 /dev/rdisk/c0t0d0
Volume Group configuration for /dev/vg02 has been saved in
/etc/lvmconf/vg02.conf
```

Current Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	736

VGRA space (Kbytes) on Physical Volumes with extents in use:

PV	current	-n
/dev/rdisk/c0t0d0	2784	4096
/dev/rdisk/c0t1d0	896	4096
/dev/rdisk/c0t3d0	896	4096
Summary	896	4096

Volume Group optimized settings (no PEs renumbered):

max_pv(-p)	max_pe(-e)	Disk size (Mb)
3	35836	143345
4	26876	107505
* Entries deleted for brevity		
38	2812	11249
42	2556	10225
46	2300	9201
52	2044	8177
60	1788	7153
* Entries deleted for brevity		
255	252	1009

Compare this table with the previous one to see how the bootable disk is limiting the values. This is even more noticeable if you use the `-tvn` options with `-B n`. From the table select the values desired. The example shows `-p 42` and `-e 2556`.

- Review the mode for the new settings. You can run the review mode with and without the `-a` option. The `-a` option indicates that the `vgmodify` command can be run when the volume group is active (online `vgmodify`).

```
# vgmodify -r -p 42 -e 2556 -B n vg02 /dev/rdisk/c0t0d0
```

```
Volume Group configuration for /dev/vg02 has been saved in
/etc/lvmconf/vg02.conf
```

Current Volume Group settings:

Max LV	255
Max PV	16
Max PE per PV	5119
PE Size (Mbytes)	4
VGRA Size (Kbytes)	736

The current and new Volume Group parameters differ.

Physical Volume `"/dev/rdisk/c1t0d0"` the current and new settings differ

An update to the Volume Group IS required

New Volume Group settings:

Max LV	255
Max PV	42
Max PE per PV	2556
PE Size (Mbytes)	4

Review complete. Volume group not modified

4. Make the change.

For offline mode, deactivate the volume group before performing the actual operation and run vgmodify without the -a option.

```
# vgchange -a n vg02          # For offline mode only
Volume group "vg02" has been successfully changed.
```

```
# vgmodify -v -p 42 -e 2556 -B n vg02 /dev/rdisk/c0t0d0
# Offline mode
```

or

```
# vgmodify -a -v -p 42 -e 2556 -B n vg02 /dev/rdisk/c0t0d0
# Online mode
```

Volume Group configuration for /dev/vg02 has been saved in /etc/lvmconf/vg02.conf

Current Volume Group settings:

```
Max LV      255
Max PV      16
Max PE per PV 5119
PE Size (Mbytes) 4
VGRA Size (Kbytes) 736
```

/dev/rdisk/c0t0d0 Warning: Max_PE_per_PV for the volume group (2556) too small for this PV (5119).

Using only 2556 PEs from this physical volume.

/dev/rdisk/c0t1d0 Warning: Max_PE_per_PV for the volume group (2556) too small for this PV (5119).

Using only 2556 PEs from this physical volume.

/dev/rdisk/c0t3d0 Warning: Max_PE_per_PV for the volume group (2556) too small for this PV (5119).

Using only 2556 PEs from this physical volume.

The current and new Volume Group parameters differ.

Physical Volume "/dev/rdisk/c0t0d0" the current and new settings differ

Physical Volume "/dev/rdisk/c0t1d0" the current and new settings differ

Physical Volume "/dev/rdisk/c0t3d0" the current and new settings differ

An update to the Volume Group IS required

New Volume Group settings:

```
Max LV      255
Max PV      42
Max PE per PV 2556
PE Size (Mbytes) 4
VGRA Size (Kbytes) 896
```

New Volume Group configuration for "vg02" has been saved in "/etc/lvmconf/vg02.conf"

Old Volume Group configuration for "vg02" has been saved in "/etc/lvmconf/vg02.conf.old"

Starting the modification by writing to all Physical Volumes

Applying the configuration to all Physical Volumes from "/etc/lvmconf/vg02.conf"

Volume Group configuration has been restored to /dev/rdisk/c0t0d0

Volume Group configuration has been restored to /dev/rdisk/c0t1d0

Volume Group configuration has been restored to /dev/rdisk/c0t3d0

Completed the modification process.

New Volume Group configuration for "vg02" has been saved in "/etc/lvmconf/vg02.conf.old"

Volume group "vg02" has been successfully changed.

For offline mode, activate the volume group.

```
# vgchange -a y vg02
Activated volume group
Volume group "vg02" has been successfully changed.
```

5. Verify the changes.

```
# vgsdisplay vg02
--- Volume groups ---
VG Name                /dev/vg02
VG Write Access        read/write
VG Status              available
Max LV                 255
Cur LV                0
Open LV               0
Max PV                 42
Cur PV                3
Act PV                3
Max PE per PV         2556
VGDA                   6
PE Size (Mbytes)      4
Total PE              7668
Alloc PE               0
Free PE               7668
Total PVG              0
Total Spare PVs       0
Total Spare PVs in use 0
VG Version             1.0
VG Max Size            429408m
VG Max Extents         107352
```

```
# vgcfgrestore -l -n vg02
Volume Group Configuration information in "/etc/lvmconf/vg02.conf"
VG Name /dev/vg02
---- Physical volumes : 2 ----
  /dev/rdisk/c0t0d0 (Non-bootable)
  /dev/rdisk/c0t1d0 (Non-bootable)
  /dev/rdisk/c0t3d0 (Non-bootable)
```

The physical volume /dev/rdisk/c0t0d0 is changed from bootable to non-bootable.

LVM vgmodify Messages for Version 1.0 volume groups

- Developing a new set of PVIDs. This will take approximately 10 seconds

When `vgmodify` makes any changes to the volume group, a new physical volume identifier (PVID) is created for each physical volume. This can take one second per physical volume in the volume group. A new PVID ensures that a partial restoration from a configuration backup file created before this modification does not lead to a mixed configuration.

- "/dev/rdisk/c2t3d0" size changed from 768000 to 8700000kb

`vgmodify` detected that the size of `c2t3d0` has changed. When the physical volume was created (see `pvccreate(1M)`), it was 768,000 kb it is now 8,700,000 kb. This detail is reported when using the `-v` argument.

- Expected 5 Physical Volumes but only found 4

The volume group has five physical volumes, but `vgmodify` can only locate four. Verify that all five physical volumes are accessible. The `vgmodify` command cannot continue until it can access all five.

- VGRA space (Kbytes) without PE renumbering

The amount of space available for the VGRA when physical extent renumbering is left unchanged.

- VGRA space (Kbytes) PE renumbering lower

The amount of space available for the VGRA when physical extents are renumbered lower so that the first physical extent can be used for metadata. All physical extent numbers are reduced by one.

- VGRA space (Kbytes) PE renumbering higher

The amount of space available for the VGRA when physical extents are renumbered higher so that metadata space can be returned to user space. All physical extent numbers are increased by one.

- Prior to modification test IO to `"/dev/rdisk/c2t3d0"` failed

Before making any modifications, a test write is performed to each physical volume. The test write failed to this device. `vgmodify` stopped before making any changes applicable to the new configuration. Check the device before repeating the command.

- Physical Volume `"/dev/rdisk/c2t3d0"` is already the type requested

The `-B` option was used with `c2t3d0` in the list of physical volumes, but this physical volume is already the type requested. It is already bootable if `-B y`, or non-bootable if `-B n`.

- Installing the new configuration was partially successful. Examine `vgcfgrestore(1M)` messages to understand which disks may require manual restoration from the `"/etc/lvmconf/vg01.conf"` file. The Volume Group should activate in its current state without quorum override but not all disks may attach.

`vgmodify` was partially successfully in placing the new configuration onto the physical volumes but some failed. You will see error messages from `vgcfgrestore` prior to this message. Check the disks associated with the failures and then manually restore to these disks.

- The space available for the configuration data will be limited by having bootable disks. If this is not a boot VG then consider changing the type, using `-B n`, of the following bootable disks:

```
/dev/rdisk/c2t3d0  
/dev/rdisk/c3t4d0
```

Bootable disks (disks created using `pvcreate -B` or changed type using `vgmodify -B y`) limit the space available for the VGRA. If this is not a boot volume group, use `-B n` to change all the disks in the list to non-boot.

- Physical Extent zero is not free on all PVs. You will not achieve these values until the first extent is made free (see `pvmove(1M)`) on all the following disks:
`/dev/rdisk/c2t4d0`

`vgmodify` was run with `-n` and it wants to lower the physical extent numbers on `c2t4d0`, but to do this the first extent must be free so that its space can be given over to metadata.

- VGRA for the disk is too big for the specified parameters. Decrease `max_PVs` and/or `max_PEs`.

The selected `max_pv` and `max_pe` values create a VGRA that is too large for the space available on all physical volumes. The VGRA cannot be greater than the physical extent size.

- `"/dev/rdisk/c2t4d0"` size is limited by the maximum extents per PV to 56934400.

The disk `/dev/rdisk/c2t4d0` was resized to a size greater than 56934400, but because of the limitation of the current value of `max_PE`, LVM can only use 56934400 of the disk space.

- Error: The physical volume `"/dev/rdisk/c2t4d0"` does not need to be reconfigured since the newly added space is less than the size of one extent.
The disk `/dev/rdisk/c2t4d0` was increased by a size less than the size of one physical extent.
- The physical volume `"/dev/rdisk/c4t2d0"` can be prepared for contraction to 40003 MB without having to move any physical extents on it.

The minimum size to which the disk `/dev/rdisk/c4t2d0` can be reduced without having to move any of the physical extents.

- The physical volume `"/dev/rdisk/c4t2d0"` can be prepared for contraction to a minimum size of 40003 MB after freeing up the last 7501 physical extents.

The minimum size to which the disk `/dev/rdisk/c4t2d0` can be reduced after freeing up the last extents 7501 extents using `pvmove(1M)` command.

- Error: The specified size for physical volume `"/dev/rdisk/c4t2d0"` is too small. The minimum size to which the physical volume can be contracted to is 200 MB.

The specified size for the physical volume `/dev/rdisk/c4t2d0` in the command line for DLC is less than the metadata size.

vgmodify for Version 2.0 volume groups

This section describes how to use the `vgmodify` command to perform online dynamic LUN expansion (DLE), online dynamic LUN contraction (DLC), and online volume group reprovisioning (changing maximum VG size) for Version 2.x volume groups.

The `vgmodify` command for Version 2.x volume groups is available in the HP-UX 11i v3 March 2009 Update. For information on using `vgmodify` on Version 1.0 volume groups, see the `vgmodify` for Version 1.0 volume groups section.

Command differences between Version 1.0 and 2.x volume groups

For Version 2.x volume groups, the `vgmodify` command has the following differences from the `vgmodify` command for Version 1.0 volume groups:

- **Modes**
It is only supported for activated volume groups (online mode). For Version 1.0 volume groups, the `vgmodify` command has an offline mode and an online mode.
- **Options**
Has a `-S` option to select the maximum volume group size (for reprovisioning) that is not available for Version 1.0 volume groups. The following options available for Version 1.0 volume groups are not applicable for Version 2.x volume groups: `-e` (for max PEs per PV), `-p` (for max PVs), `-l` (for max LVs), and `-t` (table mode). For a complete list of Version 1.0 and 2.x options, see `vgmodify(1M)`.
- **Operation**
The `vgmodify` command for Version 1.0 volume groups suspends the volume group in certain cases and performs the reconfiguration using `vgcfgrestore`. The `vgmodify` command for Version 2.x does not suspend the volume group and modifies the on-disk configuration data without requiring a `vgcfgbackup` file.
- **Output messages**
The `vgmodify` output messages for Versions 1.0 volume groups are different from the output messages for Version 2.x volume groups.

Command similarities between Version 1.0 and 2.x volume groups

The `vgmodify` command options for online DLE and online DLC are the same for Version 1.0 and Version 2.x volume groups. For online DLE, the `-a` and `-E` options are required. Online DLE can target a single PV, all PVs in the VG, or selected PVs. For online DLC, the `-a` and `-C` options are required. Online DLC requires a `DLC_size` parameter, and must target a single PV.

The `-r` option is the review mode option for both versions. Without the `-r` option (and without the `-t` option in Version 1.0), `vgmodify` runs in change mode, in which it attempts to reconfigure the volume group.

Command line options

The `vgmodify` command for Version 2.x volume groups supports the following tasks and command line syntaxes:

- Reconfigure physical volumes for dynamic LUN expansion (DLE)
`vgmodify -a -E [-r] VolumeGroupName [pv_path ...]`
- Reconfigure a physical volume for dynamic LUN contraction (DLC)

```
vgmodify -a -C DLC_Size [-r] VolumeGroupName pv_path
```

- Reconfigure physical volumes for a change in the maximum volume group size

```
vgmodify -a [-E] -S Max_VG_Size [-r] VolumeGroupName
```

The `-a` option is required in all cases because the `vgmodify` command for Version 2.x volume groups is only supported on activated volume groups. For a complete list of options, see `vgmodify(1M)`.

Command usage

In the following cases, you can use the `vgmodify` command to reconfigure a Version 2.x volume group. In all cases, the operation is performed while the volume group is activated. User applications can continue running without disruption (they might continue sending I/Os to the logical volumes in the volume group).

For more information on Version 2.x volume groups and maximum limits (for example, maximum volume group size, maximum logical volume size, and maximum number of physical volumes and logical volumes), see the following LVM Version 2.x whitepapers located on docs.hp.com:

- *LVM Version 2.x Volume Groups in HP-UX 11i v3* (September 2008)
- *LVM Limits White Paper* (September 2008)

For information on how to set the maximum volume group size limit at volume group creation time on Version 2.x volume groups, see `vgcreate(1M)` and `lvm(7)`.

For information on how to display limits for Version 2.x volume groups, see `vgdisplay(1M)` and `lvmdm(1M)`.

Most high-end storage arrays (for example, HP Enterprise Virtual Array) provide utilities that can expand or contract the size of a LUN without disrupting the applications using the LUN. These features are called online dynamic LUN expansion (DLE) and online dynamic LUN contraction (DLC).

Online DLE to increase the space available for user data

The LUN for a physical volume was dynamically expanded using a storage utility (such as those available on EVA arrays) and the physical volume needs to be reconfigured using online `vgmodify` DLE (`-E` option) to make use of the new space for user data. After the physical volume is reconfigured, you can expand the logical volumes containing the user data with `lvextend`, or you can create new logical volumes with `lvcreate`.

Online DLE to increase the space available for LVM configuration data

The LUN for a physical volume was dynamically expanded using a storage utility (such as those available on EVA arrays) and the physical volume needs to be reconfigured using online `vgmodify` DLE (`-E` option) to make use of the new space for LVM configuration data. For example, following online `vgmodify` DLE, you can invoke `vgmodify` with the `-S` option to use the new space to increase the maximum volume group size. You can also specify the `-E` and `-S` options together to perform DLE and maximum VG size increase in a single step. LVM uses the space it needs to increase the maximum VG size and any leftover space is made available as new extents for user data.

Online reprovisioning to increase the maximum volume group size

The maximum VG size you chose when you invoked `vgcreate` needs to be increased to allow more extents to be added to the VG, either through DLE or by adding more PVs. You can use the online `vgmodify -S` option to increase (or reprovision) the maximum VG size. Increasing the maximum VG size might require that additional space be added to every PV through DLE. In this case, you can invoke the `-E` and `-S` options together to handle the LUN expansions and increase the maximum VG size in a single step. LVM might also use free extents at the ends of the PVs to increase the maximum VG size. If insufficient free extents are available at the end of some PVs, and those PVs cannot be expanded further via DLE, it might be necessary to make the extents at the ends of those PVs free by using the `pvmove` command to relocate the portions of the logical volumes that are using those extents. The maximum VG size is not changed until all PVs in the VG are reconfigured.

Online DLC to decrease the space used by a physical volume

A physical volume needs to be reconfigured to prepare the LUN for dynamic contraction. You can use the online `vgmodify DLC -C` option to prepare the LUN. In some cases, free extents at the end of the PV might need to be removed. If insufficient free extents are available at the end of the PV, it might be necessary to make the extents at the end of the PV free by using the `pvmove` command to relocate the portions of the logical volumes that are using those extents. After the LUN is prepared, you can use the appropriate storage device utility (such as those available on EVA arrays) to contract the LUN.

The use case for this is a LUN that has been over-provisioned, and the LUN is being contracted to reclaim the space for use by other LUNs. If a DLC is performed on the storage device without first preparing the physical volume for DLC with the `vgmodify` command, the LUN is marked as unavailable.

Online reprovisioning to decrease the maximum volume group size

The maximum VG size chosen at `vgcreate` time is larger than necessary for the application using the volume group. You can use the online `vgmodify -S` option to decrease (or reprovision) the maximum VG size. The maximum VG size is changed immediately in this case, and LVM proceeds to reconfigure all PVs in the VG to decrease the amount of space used for LVM configuration data and make the space available as new extents for user data.

Online vgmodify

This section provides the typical procedures for using the `vgmodify` command to perform online dynamic LUN expansion (DLE), online dynamic LUN contraction (DLC), and online volume group reprovisioning (changing maximum VG size) for Version 2.x volume groups.

Prerequisites

- The volume group must be active.
- The volume group must not be activated in shared mode or read-only mode.
- The volume group must not be in the quiesced state.
- The volume group must not have a cluster lock physical volume. The `cmviewcl -v` command displays the device path name of the disk configured as a cluster lock LUN.
- The increase (DLE) or decrease (DLC) in disk size must be greater than the size of a physical extent on the physical volume.

Online DLE

1. Determine which physical volumes in the volume group require expansion and decide how much each LUN needs to be expanded. This decision can be based on which logical volumes need to grow and which physical volumes they reside on. Use the `lvdisplay -v` command to assist in this analysis. This decision can also be based on whether or not the DLE is being performed as part of increasing the maximum VG size. See the reprovisioning procedure in this section for a description of DLE in combination with reprovisioning.
2. For each physical volume being expanded, run the appropriate storage utility to expand the LUN. Verify that the LUN is expanded by running the `diskinfo` command.
3. Use the `vgmodify` review mode to verify which physical volumes require reconfiguration for DLE and to check if the reconfiguration will yield the desired results. If no PVs are listed on the command line, `vgmodify` checks all PVs in the VG. Optionally, you can list the PVs you want to check in the command line after the VG name.

```
# vgmodify -r -a -E vg1          # Review mode (-r)
```
4. Perform the actual DLE reconfiguration (change mode). If no PVs are listed on the command line, `vgmodify` attempts reconfiguration on all PVs in the VG (if it detects them as having been expanded). Optionally, you can list the PVs you want to reconfigure in the command line after the VG name.

```
# vgmodify -a -E vg1          # Change mode (-r removed)
```

5. Verify the result of the DLE reconfiguration by running the `vgdisplay -v` command to check the total number of extents for the VG, the total number of free extents for the VG, the number of extents for each PV, and the number of free extents for each PV.

Online DLC

1. Determine which physical volume is over-provisioned and decide what the new (smaller) PV size will be. Use the `pvdisplay -v` command to assist in this decision by displaying the total number of extents for the PV and the number of free extents for the PV. It also shows if the extents at the end of the PV are free. If the PV has no free extents, you might need the `pvmove` command to relocate the portions of the logical volumes residing on the extents at the end of the PV.
2. Use the `vgmodify` review mode to verify if the desired (smaller) PV size will be too small. If the new PV size requires extents to be removed that are allocated to logical volumes, `vgmodify` reports that the specified PV size is too small and reports the smallest PV size that the PV can be contracted to.

```
# vgmodify -r -a -C 8g vg1 /dev/rdisk/disk50 # Review mode (-r)
```

3. Perform the actual DLC reconfiguration (change mode).

```
# vgmodify -a -C 8g vg1 /dev/rdisk/disk50 # Change mode (-r removed)
```

4. Verify the result of the DLC reconfiguration by running the `vgdisplay -v` command to check the total number of extents for the VG, the total number of free extents for the VG, the total number of extents for the PV, and the number of free extents for the PV. The size of the PV reported by `pvdisplay` (determined by multiplying extent size by total number of extents) must be less than or equal to the size that the LUN is going to be contracted to.
5. Run the appropriate storage utility to contract the LUN to the new (smaller) size. If the LUN is contracted to a size smaller than what `pvdisplay` reported, the PV is marked as unavailable.

Online reprovisioning to increase the maximum volume group size

Use this procedure when the volume group reaches its maximum VG size limit.

You initially set the maximum VG size when you created the Version 2.x volume group with the `vgcreate` command. Use the `vgdisplay` command to view the maximum VG size. The largest maximum VG size that you can select in `vgcreate` and `vgmodify` for Versions 2.0 and 2.1 is 2 PB. This value is listed in the `lvmadm -t` command output, which displays all of the Version 1.0 and 2.x limits. For more information on maximum size limits for Version 2.x volume groups, see the whitepapers and manpages in the Command usage section.

When the maximum VG size is reached, the `vgdisplay` output shows that the Total PE count for the VG matches the VG Max Extents count. Typically, when the maximum VG size limit is reached, the last PV that was added through `vgcreate` or `vgextend` was not fully configured. In other words, the number of extents configured for the last PV are typically not to the full capacity of the PV. Also, if the VG is at its maximum VG size limit, a `vgextend` attempt to add another PV fails with the `Error: The volume group exceeds the configured size` message. In addition, a `vgmodify` DLE attempt reports that no additional extents were added to the VG.

At that point, if the volume group has no more free extents, logical volumes cannot be expanded. If more space is needed for storing additional user data, use the `vgmodify` command to increase the maximum VG size.

A minimum extent size of 64 MB is required for the maximum VG size limit of 2 PB for Versions 2.0 and 2.1, as reported by the `vgcreate -V 2.x -E -S 2p` command. If the volume group extent size is less than 64 MB, use the `vgcreate -V 2.x -E -s extent_size` command to determine the maximum possible VG size limit.

To increase the maximum VG size for the volume group, follow these steps:

1. Use the `vgmodify` review mode to verify there is enough free space on all of the physical volumes to reconfigure them to the desired maximum VG size. The `vgmodify` command checks for free extents at the ends of the PVs that it can utilize, and also checks for free space resulting from prior LUN expansions. You must provide the `-E` option and the `-S` option for review mode to check for LUN expansions. It might be necessary to use the `pvmove` command to relocate the portions of logical volumes residing at the ends of the PVs.


```
# vgmodify -r -a -E -S 64t vg1          # Review mode (-r)
```
2. If review mode reports that the maximum VG size can be increased, perform the actual reprovisioning reconfiguration. This operation reconfigures every PV in the VG to the new (larger) maximum VG size. The maximum VG size as reported by the `vgdisplay` command is not changed until every PV is reconfigured. This operation also automatically adds new extents to PVs where the new extents were not added previously because the volume group was at its maximum number of extents.


```
# vgmodify -a -E -S 64t vg1          # Change mode (-r removed)
```
3. Verify the result of the reprovisioning reconfiguration by running the `vgdisplay -v` command to check the new maximum VG size, the new maximum number of extents for the VG, and additional extents that might have been added to some of the PVs.
4. If any `vgextend` commands were previously unable to add PVs to the volume group, rerun those commands now. The `vgextend` commands must succeed in adding more PVs to the VG. Run `vgdisplay -v` to verify that more free extents are available.
5. Expand logical volumes using `lvextend -l` as necessary to allow them to accommodate more user data. You can also create additional logical volumes using `lvcreate`. You can also add additional mirrors using `lvextend -m`.

Online reprovisioning to decrease the maximum volume group size

You can set the maximum VG size value for a volume group to a lower value as long as the volume group has not already reached that size. Use the `vgdisplay` command to see the current maximum VG size, the total number of extents, and the number of free extents. The current size of the VG is the total number of extents times the extent size.

To decrease the maximum VG size for the volume group, follow these steps:

1. Use the review mode of `vgmodify` to verify that the volume group maximum VG size can be decreased to the desired new (lower) value.


```
# vgmodify -r -a -S 32t vg1          # Review mode (-r)
```
2. If review mode reports that the maximum VG size can be decreased, perform the actual reprovisioning reconfiguration. The maximum VG size as reported by `vgdisplay` is reduced immediately, then `vgmodify` reconfigures every PV in the VG to reduce the amount of space being used for LVM configuration data. The unused space is made available as new extents for user data.


```
# vgmodify -a -S 32t vg1          # Change mode (-r removed)
```
3. Verify the result of the reprovisioning reconfiguration by running the `vgdisplay -v` command to check the new maximum VG size, the new maximum number of extents for the VG, the new total number of extents for the VG, and the new number of free extents for the VG.

Common Version 2.x examples

This section provides detailed examples for using the `vgmodify` command to perform online dynamic LUN expansion (DLE), online dynamic LUN contraction (DLC), and online volume group reprovisioning (changing maximum VG size) for version 2.x volume groups.

The volume group is active in all of the examples unless otherwise noted.

Display values that have changed following reconfigurations are shown in **bold**.

Online DLE examples

Online DLE where all additional disk space can be allocated

This example assumes a volume group with three 100 GB disks on which one logical volume with three mirrors has used up all of the extents. You need to double the size of the logical volume to make room for more data. Therefore, you plan to double the size of each of the three LUNs from 100 GB to 200 GB.

1. Review current volume group and LUN attributes.

```
# vgdisplay -v vg1
--- Volume groups ---
VG Name                /dev/vg1
...
PE Size (Mbytes)      8
Total PE              38370
Alloc PE              38370
Free PE               0
...
VG Version            2.1
VG Max Size           32t
VG Max Extents       4194304

--- Logical volumes ---
LV Name                /dev/vg1/lvol1
LV Status              available/syncd
LV Size (Mbytes)      102320
Current LE            12790
Allocated PE          38370
Used PV               3

--- Physical volumes ---
PV Name                /dev/disk/disk46
PV Status              available
Total PE              12790
Free PE               0
...
PV Name                /dev/disk/disk47
PV Status              available
Total PE              12790
Free PE               0
...
PV Name                /dev/disk/disk48
PV Status              available
Total PE              12790
Free PE               0
...

# diskinfo /dev/rdisk/disk46
SCSI describe of /dev/rdisk/disk46:
...
    size: 104857600 Kbytes
...

# diskinfo /dev/rdisk/disk47
SCSI describe of /dev/rdisk/disk47:
...
    size: 104857600 Kbytes
...

# diskinfo /dev/rdisk/disk48
```

```
SCSI describe of /dev/rdisk/disk48:
```

```
...  
size: 104857600 Kbytes
```

2. Runs a storage utility to expand the LUNs from 100 GB to 200 GB.
3. Verify the LUNs are larger with the `diskinfo` command as follows:

```
# diskinfo /dev/rdisk/disk46  
SCSI describe of /dev/rdisk/disk46:  
...  
size: 209715200 Kbytes  
...
```

```
# diskinfo /dev/rdisk/disk47  
SCSI describe of /dev/rdisk/disk47:  
...  
size: 209715200 Kbytes  
...
```

```
# diskinfo /dev/rdisk/disk48  
SCSI describe of /dev/rdisk/disk48:  
...  
size: 209715200 Kbytes
```

4. Run online `vgmodify` in review mode to verify that the PVs require reconfiguration for the DLE and to preview the number of new extents to be added:

```
# vgmodify -r -a -E vg1  
Physical volume "/dev/disk/disk46" requires reconfiguration for  
expansion.  
Current number of extents: 12790  
Number of extents after reconfiguration: 25590  
Physical volume "/dev/disk/disk46" was not changed.
```

```
Physical volume "/dev/disk/disk47" requires reconfiguration for  
expansion.  
Current number of extents: 12790  
Number of extents after reconfiguration: 25590  
Physical volume "/dev/disk/disk47" was not changed.
```

```
Physical volume "/dev/disk/disk48" requires reconfiguration for  
expansion.  
Current number of extents: 12790  
Number of extents after reconfiguration: 25590  
Physical volume "/dev/disk/disk48" was not changed.
```

5. Run online `vgmodify` in change mode to perform the reconfiguration:

```
# vgmodify -a -E vg1  
Reconfiguration to expand physical volume "/dev/disk/disk46"  
succeeded.  
Previous number of extents: 12790  
Number of extents after reconfiguration: 25590  
Physical volume "/dev/disk/disk46" was changed.
```

```
Volume Group configuration for /dev/vg1 has been saved in  
/etc/lvmconf/vg1.conf
```

```
Reconfiguration to expand physical volume "/dev/disk/disk47"  
succeeded.  
Previous number of extents: 12790  
Number of extents after reconfiguration: 25590  
Physical volume "/dev/disk/disk47" was changed.
```

```
Volume Group configuration for /dev/vg1 has been saved in  
/etc/lvmconf/vg1.conf
```

Reconfiguration to expand physical volume "/dev/disk/disk48" succeeded.

Previous number of extents: 12790

Number of extents after reconfiguration: 25590

Physical volume "/dev/disk/disk48" was changed.

Volume Group configuration for /dev/vg1 has been saved in /etc/lvmconf/vg1.conf

6. Verify that the PVs were reconfigured and that there are now free extents available with the `vgdisplay -v` command:

```
# vgdisplay -v vg1
--- Volume groups ---
VG Name                /dev/vg1
...
PE Size (Mbytes)      8
Total PE            76770
Alloc PE              38370
Free PE              38400
...
VG Version             2.1
VG Max Size            32t
VG Max Extents         4194304

--- Logical volumes ---
LV Name                /dev/vg1/lvol1
LV Status              available/syncd
LV Size (Mbytes)      102320
Current LE             12790
Allocated PE           38370
Used PV                3

--- Physical volumes ---
PV Name                /dev/disk/disk46
PV Status              available
Total PE            25590
Free PE              12800
...
PV Name                /dev/disk/disk47
PV Status              available
Total PE            25590
Free PE              12800
...
PV Name                /dev/disk/disk48
PV Status              available
Total PE            25590
Free PE              12800
```

7. Expand the logical volume using the free extents shown in the output of the previous step:

```
# lvextend -l 25590 /dev/vg1/lvol1
Logical volume "/dev/vg1/lvol1" has been successfully extended.
Volume Group configuration for /dev/vg1 has been saved in /etc/lvmconf/vg1.conf
```

8. Run `vgdisplay -v` to verify the LV expansion.

```
# vgdisplay -v vg1
--- Volume groups ---
VG Name                /dev/vg1
...
PE Size (Mbytes)      8
Total PE            76770
```

```

Alloc PE                               76770
Free PE                                 0
...
VG Version                                2.1
VG Max Size                               32t
VG Max Extents                            4194304

--- Logical volumes ---
LV Name                                   /dev/vg1/lvol1
LV Status                                 available/syncd
LV Size (Mbytes)                        204720
Current LE                               25590
Allocated PE                             76770
Used PV                                   3

--- Physical volumes ---
PV Name                                   /dev/disk/disk46
PV Status                                 available
Total PE                                  25590
Free PE                                    0
...

PV Name                                   /dev/disk/disk47
PV Status                                 available
Total PE                                  25590
Free PE                                    0
...

PV Name                                   /dev/disk/disk48
PV Status                                 available
Total PE                                  25590
Free PE                                    0

```

Online DLE where some additional disk space can be allocated

This example assumes a volume group with two 200 GB disks on which one logical volume with two mirrors has used up all of the extents. You want to increase the LUN sizes to 300 GB to expand the logical volume. However, you created the volume group with a relatively small maximum VG size (500 GB). When `vgmodify` tries to reconfigure the physical volumes, it is only able to increase the total number of extents to 64000 because of the 500 GB limit on the VG size. The maximum number of extents (64000) for the VG equals the maximum VG size (500 GB) divided by the extent size (8 MB).

1. Review current volume group and LUN attributes.

```

# vgsdisplay -v vg1
--- Volume groups ---
VG Name                                   /dev/vg1
...
PE Size (Mbytes)                          8
Total PE                                  51196
Alloc PE                                  51196
Free PE                                    0
...
VG Version                                2.1
VG Max Size                               500g
VG Max Extents                            64000

--- Logical volumes ---
LV Name                                   /dev/vg1/lvol1
LV Status                                 available/syncd
LV Size (Mbytes)                          204784
Current LE                                25598
Allocated PE                              51196

```

```

Used PV                2

--- Physical volumes ---
PV Name                /dev/disk/disk46
PV Status              available
Total PE              25598
Free PE               0
...

PV Name                /dev/disk/disk47
PV Status              available
Total PE              25598
Free PE               0

```

- Run a storage utility to expand the LUNs from 200 GB to 300 GB.
- Verify the LUN expansion.

```

# diskinfo /dev/rdisk/disk46
SCSI describe of /dev/rdisk/disk46:
...
    size: 314572800 Kbytes
...

# diskinfo /dev/rdisk/disk47
SCSI describe of /dev/rdisk/disk47:
...
    size: 314572800 Kbytes

```
- Run online `vgmodify` in review mode to verify that the first PV requires reconfiguration for the DLE and to check the number of new extents to be added.

```

# vgmodify -r -a -E vg1 /dev/rdisk/disk46
Physical volume "/dev/disk/disk46" requires reconfiguration for
expansion.
Current number of extents: 25598
Number of extents after reconfiguration: 38398
Physical volume "/dev/disk/disk46" was not changed.

```
- Run online `vgmodify` in change mode to perform the reconfiguration of the first PV.

```

# vgmodify -a -E vg1 /dev/rdisk/disk46
Reconfiguration to expand physical volume "/dev/rdisk/disk46"
succeeded.
Previous number of extents: 25598
Number of extents after reconfiguration: 38398
Physical volume "/dev/rdisk/disk46" was changed.

Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf

```
- View the results.

```

# vdisplay -v vg1
--- Volume groups ---
VG Name                /dev/vg1
...

PE Size (Mbytes)      8
Total PE           63996
Alloc PE           51196
Free PE            12800
...
VG Version             2.1
VG Max Size            500g
VG Max Extents         64000

```

```

--- Logical volumes ---

```

```

LV Name           /dev/vg1/lvol1
LV Status         available/syncd
LV Size (Mbytes) 204784
Current LE        25598
Allocated PE      51196
Used PV           2

```

--- Physical volumes ---

```

PV Name           /dev/disk/disk46
PV Status         available
Total PE       38398
Free PE        12800
...

```

```

PV Name           /dev/disk/disk47
PV Status         available
Total PE          25598
Free PE           0

```

7. Run online `vgmodify` in review mode to verify that the second PV requires reconfiguration for the DLE and to check the number of new extents to be added.

```

# vgmodify -r -a -E vg1 /dev/rdisk/disk47
Physical volume "/dev/rdisk/disk47" requires reconfiguration for
expansion.
Current number of extents: 25598
Number of extents after reconfiguration: 25602
Physical volume "/dev/rdisk/disk47" was not changed.

```

In this case, only 4 new extents are added because the VG already has 63996 extents (38398 + 25598) after the reconfiguration of the first PV. Therefore, you can only add four more extents before reaching the maximum number of extents for the VG (64000 = maximum VG size 500GB/extent size 8MB).

8. Run online `vgmodify` in change mode to perform the reconfiguration of the second PV.

```

# vgmodify -a -E vg1 /dev/rdisk/disk47
Reconfiguration to expand physical volume "/dev/rdisk/disk47"
succeeded.
Previous number of extents: 25598
Number of extents after reconfiguration: 25602
Physical volume "/dev/rdisk/disk47" was changed.

```

Volume Group configuration for /dev/vg1 has been saved in /etc/lvmconf/vg1.conf

9. Run `vgdisplay -v` to view the results.

```

# vgdisplay -v vg1
--- Volume groups ---
VG Name           /dev/vg1
...
PE Size (Mbytes)  8
Total PE       64000
Alloc PE       51196
Free PE        12804
...
VG Version        2.1
VG Max Size       500g
VG Max Extents    64000

```

--- Logical volumes ---

```

LV Name           /dev/vg1/lvol1
LV Status         available/syncd
LV Size (Mbytes) 204784
Current LE        25598

```

```

Allocated PE          51196
Used PV              2

--- Physical volumes ---
PV Name              /dev/disk/disk46
PV Status            available
Total PE            38398
Free PE             12800
...

PV Name              /dev/disk/disk47
PV Status            available
Total PE          25602
Free PE           4

```

To use the extra space on /dev/disk/disk47, you must increase the maximum VG size from 500 GB to a larger value, as described in the following example.

Online reprovisioning examples

Online reprovisioning when the volume group has reached its maximum VG size limit

In the previous example, only four new extents were added to /dev/disk/disk47 when the LUN was expanded from 200 GB to 300 GB because the volume group was already at 63996 extents, and the maximum number of extents is 64000 (500GB maximum VG size/8MB extent size). To add more extents to /dev/disk/disk47, you must increase the maximum VG size. In this case, you want to increase the maximum VG size to 8 TB.

1. Verify the free extents at the end of /dev/disk/disk46.

```

# pvdiskdisplay -v /dev/disk/disk46
--- Physical volumes ---
PV Name              /dev/disk/disk46
VG Name              /dev/vg1
...
PE Size (Mbytes)    8
Total PE            38398
Free PE             12800
Allocated PE        25598
...

--- Distribution of physical volume ---
LV Name              LE of LV  PE for LV
/dev/vg1/lvol1      25598    25598

--- Physical extents ---
PE   Status  LV              LE
00000 current  /dev/vg1/lvol1 00000
00001 current  /dev/vg1/lvol1 00001
00002 current  /dev/vg1/lvol1 00002
00003 current  /dev/vg1/lvol1 00003
00004 current  /dev/vg1/lvol1 00004
*Entries deleted for brevity
25593 current  /dev/vg1/lvol1 25593
25594 current  /dev/vg1/lvol1 25594
25595 current  /dev/vg1/lvol1 25595
25596 current  /dev/vg1/lvol1 25596
25597 current  /dev/vg1/lvol1 25597
25598 free     /dev/vg1/lvol1 00000
25599 free     /dev/vg1/lvol1 00000
25600 free     /dev/vg1/lvol1 00000
*Entries deleted for brevity
38393 free     /dev/vg1/lvol1 00000
38394 free     /dev/vg1/lvol1 00000
38395 free     /dev/vg1/lvol1 00000

```

```
38396 free          00000
38397 free          00000
```

2. Run online `vgmodify` in review mode to verify if the physical volumes can be reconfigured to the new (larger) maximum VG size 8TB.

```
# vgmodify -r -a -E -S 8t vg1
```

```
Physical volume "/dev/disk/disk46" requires reconfiguration to be
provisioned to the requested maximum volume group size 8388608 MB.
Current number of extents: 38398
Number of extents after reconfiguration: 38396
```

The physical volume `"/dev/disk/disk46"` can be reconfigured to the new maximum volume group size 3623256 MB without removing free extents from the end of the physical volume.

The physical volume `"/dev/disk/disk46"` can be reconfigured to the new maximum volume group size 268435456 MB by removing free extents from the end of the physical volume.
Physical volume `"/dev/disk/disk46"` was not changed.

```
Physical volume "/dev/disk/disk47" requires reconfiguration to be
provisioned to the requested maximum volume group size 8388608 MB.
Current number of extents: 25602
Number of extents after reconfiguration: 25602
```

The physical volume `"/dev/disk/disk47"` can be reconfigured to the new maximum volume group size 268435456 MB without removing free extents from the end of the physical volume.

The physical volume `"/dev/disk/disk47"` can be reconfigured to the new maximum volume group size 268435456 MB by removing free extents from the end of the physical volume.
Physical volume `"/dev/disk/disk47"` was not changed.

The output shows you can increase the maximum VG size from 500 GB to 8 TB by removing the last two extents (which are free) from the first PV. No extents need to be removed from the second PV.

The output also shows you can increase the maximum VG size to the maximum VG size value (256 TB) supported for an extent size of 8 MB by removing additional free extents from the first PV.

Finally, the output shows you can increase the maximum VG size from 512000 MB to 3623256 MB without removing any free extents from the first PV.

3. Run online `vgmodify` in change mode to reconfigure all of the physical volumes to the new (larger) maximum VG size of 8 TB.

```
# vgmodify -a -E -S 8t vg1
```

```
Reconfiguration of physical volume "/dev/disk/disk46" for the
requested maximum volume group size 8388608 MB succeeded.
Previous number of extents: 38398
Number of extents after reconfiguration: 38396
Physical volume "/dev/disk/disk46" was changed.
```

```
Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf
```

```
Reconfiguration of physical volume "/dev/disk/disk47" for the
requested maximum volume group size 8388608 MB succeeded.
Previous number of extents: 25604
Number of extents after reconfiguration: 25604
Physical volume "/dev/disk/disk47" was changed.
```

The maximum volume group size for "/dev/vg1" has been increased from 512000 MB to 8388608 MB.

Volume Group configuration for /dev/vg1 has been saved in /etc/lvmconf/vg1.conf

4. Run `vgdisplay -v` to view the results.

```
# vgdisplay -v vg1
--- Volume groups ---
VG Name                /dev/vg1
...
PE Size (Mbytes)      8
Total PE            76792
Alloc PE            51196
Free PE             25596
...
VG Version             2.1
VG Max Size         8t
VG Max Extents     1048576

--- Logical volumes ---
LV Name                /dev/vg1/lvol1
LV Status              available/syncd
LV Size (Mbytes)      204784
Current LE             25598
Allocated PE           51196
Used PV                2

--- Physical volumes ---
PV Name                /dev/disk/disk46
PV Status              available
Total PE            38396
Free PE             12798
...

PV Name                /dev/disk/disk47
PV Status              available
Total PE            38396
Free PE             12798
```

The number of extents for the second PV was increased from 25602 to 25604 when two extents were removed from the first PV. After both PVs were reconfigured, `vgmodify` then increased the maximum VG size to 8 TB, and automatically expanded the second PV from 25604 extents to 38396 extents.

5. Extend the logical volume using the free extents shown in the previous step.

```
# lvextend -l 38396 /dev/vg1/lvol1
Logical volume "/dev/vg1/lvol1" has been successfully extended.
Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf
```

6. Run `vgdisplay -v` to verify the LV expansion.

```
# vgdisplay -v vg1
/dev/vg1
--- Volume groups ---
VG Name                /dev/vg1
...
PE Size (Mbytes)      8
Total PE            76792
Alloc PE            76792
Free PE             0
...
```

```

VG Version          2.1
VG Max Size        8t
VG Max Extents     1048576

--- Logical volumes ---
LV Name            /dev/vg1/lvol1
LV Status          available/syncd
LV Size (Mbytes)  307168
Current LE        38396
Allocated PE     76792
Used PV            2

--- Physical volumes ---
PV Name            /dev/disk/disk46
PV Status          available
Total PE           38396
Free PE           0
...

PV Name            /dev/disk/disk47
PV Status          available
Total PE           38396
Free PE           0

```

Online reprovisioning in combination with DLE

In the previous examples, for a volume group with two PVs, you increased the LUN sizes from 200 GB to 300 GB, increased the maximum VG size from 500 GB to 8 TB, and increased the logical volume size from 204784 MB to 307168 MB. Now, you want to increase the maximum VG size even further, from 8 TB to 128 TB. However, because there are no free extents left at the ends of the two physical volumes, you must perform online reprovisioning in combination with DLE. To do this, you first expand the LUNs from 300 GB to 400 GB, and then perform online reprovisioning in combination with DLE to increase the maximum VG size to 128 TB.

1. Run online `vgmodify` in review mode.

```

# vgmodify -r -a -S 128t vg1
vgmodify: Error: Cannot reconfigure physical volume
"/dev/disk/disk46" to the
requested maximum volume group size 134217728 MB without moving
extent(s). The last 30 extent(s) have to be made free
(see pvmove(1M)) to be able to reconfigure the physical volume.

```

The physical volume `"/dev/disk/disk46"` can be reconfigured to the new maximum volume group size 11884952 MB without removing free extents from the end of the physical volume.
Physical volume `"/dev/disk/disk46"` was not changed.

```

vgmodify: Error: Cannot reconfigure physical volume
"/dev/disk/disk47" to the
requested maximum volume group size 134217728 MB without moving
extent(s). The last 30 extent(s) have to be made free
(see pvmove(1M)) to be able to reconfigure the physical volume.

```

The physical volume `"/dev/disk/disk47"` can be reconfigured to the new maximum volume group size 11884952 MB without removing free extents from the end of the physical volume.
Physical volume `"/dev/disk/disk47"` was not changed.

You cannot increase the maximum volume group size from 8 TB to 128 TB without either shrinking the logical volume or increasing the LUN sizes further with a DLE.

2. Run a storage utility to expand the LUNs from 300 GB to 400 GB.
3. Verify the increases LUN size.

```
# diskinfo /dev/rdisk/disk46
SCSI describe of /dev/rdisk/disk46:
...
    size: 419430400 Kbytes
...
```

```
# diskinfo /dev/rdisk/disk47
SCSI describe of /dev/rdisk/disk47:
...
    size: 419430400 Kbytes
```

- 4. Run online `vgmodify` in review mode to verify that the maximum VG size can be increased from 8 TB to 128 TB if reprovisioning (`-S`) is performed in combination with DLE (`-E`).

```
# vgmodify -r -a -E -S 128t vg1
Physical volume "/dev/disk/disk46" requires reconfiguration to be
provisioned to the requested maximum volume group size 134217728
MB.
Current number of extents: 38396
Number of extents after reconfiguration: 51166
```

The physical volume `"/dev/disk/disk46"` can be reconfigured to the new maximum volume group size 268435456 MB without removing free extents from the end of the physical volume.

The physical volume `"/dev/disk/disk46"` can be reconfigured to the new maximum volume group size 268435456 MB by removing free extents from the end of the physical volume.
Physical volume `"/dev/disk/disk46"` was not changed.

```
Physical volume "/dev/disk/disk47" requires reconfiguration to be
provisioned to the requested maximum volume group size 134217728
MB.
Current number of extents: 38396
Number of extents after reconfiguration: 51166
```

The physical volume `"/dev/disk/disk47"` can be reconfigured to the new maximum volume group size 268435456 MB without removing free extents from the end of the physical volume.

The physical volume `"/dev/disk/disk47"` can be reconfigured to the new maximum volume group size 268435456 MB by removing free extents from the end of the physical volume.
Physical volume `"/dev/disk/disk47"` was not changed.

- 5. Run online `vgmodify` in change mode to perform the reprovisioning in combination with DLE.

```
# vgmodify -a -E -S 128t vg1
Reconfiguration of physical volume "/dev/disk/disk46" for the
requested maximum volume group size 134217728 MB succeeded.
Previous number of extents: 38396
Number of extents after reconfiguration: 51166
Physical volume "/dev/disk/disk46" was changed.
```

Volume Group configuration for `/dev/vg1` has been saved in `/etc/lvmconf/vg1.conf`

```
Reconfiguration of physical volume "/dev/disk/disk47" for the
requested maximum volume group size 134217728 MB succeeded.
Previous number of extents: 38396
Number of extents after reconfiguration: 51166
Physical volume "/dev/disk/disk47" was changed.
```

The maximum volume group size for `"/dev/vg1"` has been

increased from 8388608 MB to 134217728 MB.

Volume Group configuration for /dev/vg1 has been saved in /etc/lvmconf/vg1.conf

6. Verify the increased maximum VG size.

```
# vgdisplay -v vg1
--- Volume groups ---
VG Name                /dev/vg1
...
PE Size (Mbytes)      8
Total PE            102332
Alloc PE            76792
Free PE             25540
...
VG Version             2.1
VG Max Size         128t
VG Max Extents     16777216

--- Logical volumes ---
LV Name                /dev/vg1/lvol1
LV Status              available/syncd
LV Size (Mbytes)      307168
Current LE             38396
Allocated PE          76792
Used PV                2

--- Physical volumes ---
PV Name                /dev/disk/disk46
PV Status              available
Total PE            51166
Free PE             12770
...
PV Name                /dev/disk/disk47
PV Status              available
Total PE            51166
Free PE             12770
```

Online reprovisioning without DLE

In the previous examples, for a volume group with two PVs, you increased the LUN sizes from 200 GB to 300 GB to 400 GB, increased the maximum VG size from 500 GB to 8 TB to 128 TB, and increased the logical volume size from 204784 MB to 307168 MB. In this example, you want to increase the maximum VG size from 128 TB to 256 TB. Because there are free extents at the ends of the PVs (which can be verified with `pvdiskdisplay -v`), you can do the reprovisioning without DLE.

1. Run online `vgmodify` in review mode to verify you can increase the maximum VG size from 128 TB to 256 TB through reprovisioning (`-s`) without DLE.

```
# vgmodify -r -a -S 256t vg1
Physical volume "/dev/disk/disk46" requires reconfiguration to be
provisioned to the requested maximum volume group size 268435456
MB.
Current number of extents: 51166
Number of extents after reconfiguration: 51133
```

The physical volume "/dev/disk/disk46" can be reconfigured to the new maximum volume group size 135712104 MB without removing free extents from the end of the physical volume.

The physical volume "/dev/disk/disk46" can be reconfigured to the new maximum volume group size 268435456 MB by removing free extents from the end of the physical volume.

Physical volume "/dev/disk/disk46" was not changed.

Physical volume "/dev/disk/disk47" requires reconfiguration to be provisioned to the requested maximum volume group size 268435456 MB.

Current number of extents: 51166

Number of extents after reconfiguration: 51133

The physical volume "/dev/disk/disk47" can be reconfigured to the new maximum volume group size 135712104 MB without removing free extents from the end of the physical volume.

The physical volume "/dev/disk/disk47" can be reconfigured to the new maximum volume group size 268435456 MB by removing free extents from the end of the physical volume.

Physical volume "/dev/disk/disk47" was not changed.

Current number of extents: 38396

Number of extents after reconfiguration: 51166

In this case, 33 free extents will be removed from the ends of both physical volumes to accommodate the maximum VG size increase.

2. Run online `vgmodify` in change mode to reconfigure the PVs for the maximum VG size increase from 128 TB to 256 TB.

```
# vgmodify -a -S 256t vg1
```

Reconfiguration of physical volume "/dev/disk/disk46" for the requested maximum volume group size 268435456 MB succeeded.

Previous number of extents: 51166

Number of extents after reconfiguration: 51133

Physical volume "/dev/disk/disk46" was changed.

Volume Group configuration for /dev/vg1 has been saved in /etc/lvmconf/vg1.conf

Reconfiguration of physical volume "/dev/disk/disk47" for the requested maximum volume group size 268435456 MB succeeded.

Previous number of extents: 51166

Number of extents after reconfiguration: 51133

Physical volume "/dev/disk/disk47" was changed.

The maximum volume group size for "/dev/vg1" has been increased from 134217728 MB to 268435456 MB.

Volume Group configuration for /dev/vg1 has been saved in /etc/lvmconf/vg1.conf

3. Verify the maximum VG size increase.

```
# vdisplay -v vg1
```

```
--- Volume groups ---
```

```
VG Name /dev/vg1
```

```
...
```

```
PE Size (Mbytes) 8
```

```
Total PE 102266
```

```
Alloc PE 76792
```

```
Free PE 25474
```

```
...
```

```
VG Version 2.1
```

```
VG Max Size 256t
```

```
VG Max Extents 33554432
```

```
--- Logical volumes ---
```

```
LV Name /dev/vg1/lvol1
```

```

LV Status          available/syncd
LV Size (Mbytes)   307168
Current LE         38396
Allocated PE       76792
Used PV            2

--- Physical volumes ---
PV Name            /dev/disk/disk46
PV Status          available
Total PE         51133
Free PE          12737
...

PV Name            /dev/disk/disk47
PV Status          available
Total PE         51133
Free PE          12737

```

4. Expand the logical volume to make use of the additional extents.

```

# lvextend -l 51133 /dev/vg1/lvol1
Logical volume "/dev/vg1/lvol1" has been successfully extended.
Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf

```

5. Verify the LV expansion.

```

# vgdisplay -v vg1
--- Volume groups ---
VG Name            /dev/vg1
...
PE Size (Mbytes)   8
Total PE           102266
Alloc PE         102266
Free PE          0
...
VG Version          2.1
VG Max Size         256t
VG Max Extents     33554432

--- Logical volumes ---
LV Name            /dev/vg1/lvol1
LV Status          available/syncd
LV Size (Mbytes)  409064
Current LE        51133
Allocated PE      102266
Used PV            2

--- Physical volumes ---
PV Name            /dev/disk/disk46
PV Status          available
Total PE           51133
Free PE          0
...

PV Name            /dev/disk/disk47
PV Status          available
Total PE           51133
Free PE          0

```

Online DLC examples

Online DLC requiring pvmove

In the previous examples, for a volume group with two PVs, you increased the LUN sizes from 200 GB to 300 GB to 400 GB, increased the maximum VG size from 500 GB to 8 TB to 128 TB to 256 TB, and increased the logical volume size from 204784 MB to 307168 MB to 409064 MB. In this

example, you want to unmirror the logical volume and use the `pvmove` command to move half of the extents from the first PV to the second PV to allow both LUNs to be contracted.

1. Unmirror the logical volume.

```
# lvreduce -m 0 /dev/vg1/lvol1
Logical volume "/dev/vg1/lvol1" has been successfully reduced.
Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf
```

2. Review the results.

```
# lvsdisplay -v /dev/vg1/lvol1
--- Logical volumes ---
LV Name                               /dev/vg1/lvol1
...
Mirror copies                          0
...
LV Size (Mbytes)                       409064
Current LE                             51133
Allocated PE                           51133
...

--- Distribution of logical volume ---
PV Name                               LE on PV  PE on PV
/dev/disk/disk46                     51133    51133

--- Logical extents ---
LE      PV1                               PE1  Status 1
00000  /dev/disk/disk46                 00000 current
00001  /dev/disk/disk46                 00001 current
00002  /dev/disk/disk46                 00002 current
00003  /dev/disk/disk46                 00003 current
00004  /dev/disk/disk46                 00004 current
*Entries deleted for brevity
51129  /dev/disk/disk46                 51129 current
51130  /dev/disk/disk46                 51130 current
51131  /dev/disk/disk46                 51131 current
51132  /dev/disk/disk46                 51132 current

# vgsdisplay -v vg1
--- Volume groups ---
VG Name                               /dev/vg1
...
PE Size (Mbytes)                      8
Total PE                              102266
Alloc PE                             51133
Free PE                              51133
...
VG Version                             2.1
VG Max Size                             256t
VG Max Extents                          33554432

--- Logical volumes ---
LV Name                               /dev/vg1/lvol1
LV Status                             available/syncd
LV Size (Mbytes)                       409064
Current LE                             51133
Allocated PE                          51133
Used PV                                1

--- Physical volumes ---
PV Name                               /dev/disk/disk46
PV Status                             available
Total PE                              51133
```

```

Free PE          0
...

PV Name          /dev/disk/disk47
PV Status        available
Total PE         51133
Free PE        51133

```

All extents on the second PV are now free.

3. Run online `vgmodify` in review mode to verify if the first PV can be contracted.

```

# vgmodify -r -a -C 200g vg1 /dev/rdisk/disk46
vgmodify: Error: Cannot prepare physical volume "/dev/rdisk/disk46"
for contraction to the requested size 204800 MB without moving
extent(s).
The last 25600 extent(s) have to be made free (see pvmove(1M))
to be able to prepare the physical volume for contraction.
Physical volume "/dev/rdisk/disk46" was not changed.

```

The output indicates the first PV cannot be contracted without using the `pvmove` command to move some of the extents from the logical volume from the first PV to the second PV.

4. Perform a preview of using the `pvmove` command to move the last 25600 extents from disk46 to disk47.

```

# pvmove -p -e 25600 /dev/disk/disk46 /dev/disk/disk47
--- Preview of the Relocation Operation ---
Source PV          Source PE  Destination PV    Destination PE
/dev/disk/disk46   25533    /dev/disk/disk47  0
/dev/disk/disk46   25534    /dev/disk/disk47  1
/dev/disk/disk46   25535    /dev/disk/disk47  2
/dev/disk/disk46   25536    /dev/disk/disk47  3
/dev/disk/disk46   25537    /dev/disk/disk47  4
...
/dev/disk/disk46   51128    /dev/disk/disk47  25595
/dev/disk/disk46   51129    /dev/disk/disk47  25596
/dev/disk/disk46   51130    /dev/disk/disk47  25597
/dev/disk/disk46   51131    /dev/disk/disk47  25598
/dev/disk/disk46   51132    /dev/disk/disk47  25599

```

5. Move the last 25600 extents from disk46 to disk47 using `pvmove`.

```

# pvmove -e 25600 /dev/disk/disk46 /dev/disk/disk47
Transferring logical extents of logical volume "/dev/vg1/lvol1"...
Physical volume "/dev/disk/disk46" has been successfully moved.
Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf

```

6. Verify the results.

```

# pvdisplay -v /dev/disk/disk46
--- Physical volumes ---
PV Name          /dev/disk/disk46
VG Name          /dev/vg1
...
PE Size (Mbytes)      8
Total PE            51133
Free PE            25600
Allocated PE       25533
...

--- Distribution of physical volume ---
LV Name          LE of LV  PE for LV
/dev/vg1/lvol1   25533    25533

--- Physical extents ---
PE   Status  LV          LE

```

```

00000 current /dev/vg1/lvol1 00000
00001 current /dev/vg1/lvol1 00001
00002 current /dev/vg1/lvol1 00002
*Entries deleted for brevity
25530 current /dev/vg1/lvol1 25530
25531 current /dev/vg1/lvol1 25531
25532 current /dev/vg1/lvol1 25532
25533 free 00000
25534 free 00000
25535 free 00000
*Entries deleted for brevity
51130 free 00000
51131 free 00000
51132 free 00000

```

```
# pvdisplay -v /dev/disk/disk47
```

```

--- Physical volumes ---
PV Name /dev/disk/disk47
VG Name /dev/vg1
...
PE Size (Mbytes) 8
Total PE 51133
Free PE 25533
Allocated PE 25600
...

```

```
--- Distribution of physical volume ---
```

```

LV Name LE of LV PE for LV
/dev/vg1/lvol1 25600 25600

```

```
--- Physical extents ---
```

```

PE Status LV LE
00000 current /dev/vg1/lvol1 25533
00001 current /dev/vg1/lvol1 25534
00002 current /dev/vg1/lvol1 25535
*Entries deleted for brevity
25597 current /dev/vg1/lvol1 51130
25598 current /dev/vg1/lvol1 51131
25599 current /dev/vg1/lvol1 51132
25600 free 00000
25601 free 00000
25602 free 00000
*Entries deleted for brevity
51130 free 00000
51131 free 00000
51132 free 00000

```

```
# vgdisplay -v vg1
```

```

--- Volume groups ---
VG Name /dev/vg1
...
PE Size (Mbytes) 8
Total PE 102266
Alloc PE 51133
Free PE 51133
...
VG Version 2.1
VG Max Size 256t
VG Max Extents 33554432

```

```
--- Logical volumes ---
```

```

LV Name /dev/vg1/lvol1
LV Status available/syncd

```

```

LV Size (Mbytes)          409064
Current LE                51133
Allocated PE              51133
Used PV                  2

```

--- Physical volumes ---

```

PV Name                   /dev/disk/disk46
PV Status                 available
Total PE                 51133
Free PE                 25600
...

```

```

PV Name                   /dev/disk/disk47
PV Status                 available
Total PE                 51133
Free PE                 25533

```

7. Retry `vgmodify` in review mode on the first PV to verify that it can now be prepared for contraction to 200 GB.

```

# vgmodify -r -a -C 200g vg1 /dev/rdisk/disk46
Physical volume "/dev/rdisk/disk46" requires reconfiguration
for contraction to requested size 204800 MB.
Current number of extents: 51133
Number of extents after reconfiguration: 25533

```

The physical volume `"/dev/rdisk/disk46"` can be reconfigured for contraction to a minimum size of 204793 MB by removing free extents from the end of the physical volume.

Physical volume `"/dev/rdisk/disk46"` was not changed

8. Run `vgmodify` in change mode to prepare the first PV for contraction.

```

# vgmodify -a -C 200g vg1 /dev/rdisk/disk46
Reconfiguration to contract physical volume "/dev/rdisk/disk46"
to requested size 204800 MB succeeded.
Previous number of extents: 51133
Number of extents after reconfiguration: 25533
Physical volume "/dev/rdisk/disk46" was changed.

```

Volume Group configuration for `/dev/vg1` has been saved in `/etc/lvmconf/vg1.conf`

9. Verify the results.

```

# pvdisplay -v /dev/disk/disk46
--- Physical volumes ---
PV Name                   /dev/disk/disk46
VG Name                   /dev/vg1
...
PE Size (Mbytes)         8
Total PE               25533
Free PE                 0
Allocated PE             25533
...

```

--- Distribution of physical volume ---

```

LV Name                   LE of LV  PE for LV
/dev/vg1/lvol1           25533    25533

```

--- Physical extents ---

```

PE   Status  LV                   LE
00000 current  /dev/vg1/lvol1      00000
00001 current  /dev/vg1/lvol1      00001
00002 current  /dev/vg1/lvol1      00002

```

*Entries deleted for brevity

```

25530 current /dev/vg1/lvol1 25530
25531 current /dev/vg1/lvol1 25531
25532 current /dev/vg1/lvol1 25532

# vgdisplay -v vg1
--- Volume groups ---
VG Name /dev/vg1
...
PE Size (Mbytes) 8
Total PE 76666
Alloc PE 51133
Free PE 25533
...
VG Version 2.1
VG Max Size 256t
VG Max Extents 33554432

--- Logical volumes ---
LV Name /dev/vg1/lvol1
LV Status available/syncd
LV Size (Mbytes) 409064
Current LE 51133
Allocated PE 51133
Used PV 2

--- Physical volumes ---
PV Name /dev/disk/disk46
PV Status available
Total PE 25533
Free PE 0
...
PV Name /dev/disk/disk47
PV Status available
Total PE 51133
Free PE 25533

```

10. Run a storage utility to contract the first PV from 400 GB to 200 GB.

11. Verify that the LUN is smaller.

```

# diskinfo /dev/rdisk/disk46
SCSI describe of /dev/rdisk/disk46:
...
size: 209715200 Kbytes

```

Online DLC not requiring pvmove

In the previous example, you performed a DLC of the first PV from 400 GB to 200 GB, which required using `pvmove` to relocate extents of the logical volume before preparing the first PV for contraction. In this example, you decide to prepare the second PV for contraction to just 300 GB, which does not require using `pvmove` first.

1. Run `vgmodify` in review mode on the second PV to verify that it can now be prepared for contraction to 300 GB.

```

# vgmodify -r -a -C 300g vg1 /dev/rdisk/disk47
Physical volume "/dev/rdisk/disk47" requires reconfiguration
for contraction to requested size 307200 MB.
Current number of extents: 51133
Number of extents after reconfiguration: 38333

```

The physical volume `"/dev/rdisk/disk47"` can be reconfigured for contraction to a minimum size of 205329 MB by removing free extents from the end of the physical volume.

Physical volume "/dev/rdisk/disk47" was not changed.

2. Run `vgmodify` in change mode to prepare the second PV for contraction.

```
# vgmodify -a -C 300g vg1 /dev/rdisk/disk47
Reconfiguration to contract physical volume "/dev/rdisk/disk47"
to requested size 307200 MB succeeded.
Previous number of extents: 51133
Number of extents after reconfiguration: 38333
Physical volume "/dev/rdisk/disk47" was changed.
```

Volume Group configuration for /dev/vg1 has been saved in
/etc/lvmconf/vg1.conf

3. Verify the results.

```
# pvdisplay -v /dev/disk/disk47
--- Physical volumes ---
PV Name                               /dev/disk/disk47
VG Name                               /dev/vg1
...
PE Size (Mbytes)                      8
Total PE                          38333
Free PE                            12733
Allocated PE                          25600
...

--- Distribution of physical volume ---
LV Name          LE of LV  PE for LV
/dev/vg1/lvol1   25600    25600

--- Physical extents ---
PE    Status  LV                LE
00000 current  /dev/vg1/lvol1   25533
00001 current  /dev/vg1/lvol1   25534
00002 current  /dev/vg1/lvol1   25535
*Entries deleted for brevity
25597 current  /dev/vg1/lvol1   51130
25598 current  /dev/vg1/lvol1   51131
25599 current  /dev/vg1/lvol1   51132
25600 free     /dev/vg1/lvol1   00000
25601 free     /dev/vg1/lvol1   00000
25602 free     /dev/vg1/lvol1   00000
*Entries deleted for brevity
38330 free     /dev/vg1/lvol1   00000
38331 free     /dev/vg1/lvol1   00000
38332 free     /dev/vg1/lvol1   00000

# vgdisplay -v vg1
--- Volume groups ---
VG Name                               /dev/vg1
...
PE Size (Mbytes)                      8
Total PE                          63866
Alloc PE                          51133
Free PE                            12733
...
VG Version                            2.1
VG Max Size                            256t
VG Max Extents                         33554432

--- Logical volumes ---
LV Name                               /dev/vg1/lvol1
LV Status                             available/syncd
```

```

LV Size (Mbytes)          409064
Current LE                51133
Allocated PE             51133
Used PV                  2

--- Physical volumes ---
PV Name                   /dev/disk/disk46
PV Status                 available
Total PE                 25533
Free PE                  0
...

PV Name                   /dev/disk/disk47
PV Status                 available
Total PE              38333
Free PE               12733

```

4. Run a storage utility to contract the second PV from 400 GB to 300 GB.
5. Verify that the LUN is smaller.

```
# diskinfo /dev/rdisk/disk47
SCSI describe of /dev/rdisk/disk47:
```

```

...
      size: 314572800 Kbytes

```

Online reprovisioning to decrease the maximum volume group size

In this example, you know that the maximum VG size of 256 TB is more than what is needed for this volume group in the future. You want to decrease the maximum VG size to 64 TB.

1. Run `vgmodify` in review mode to verify you can decrease the maximum VG size below the current VG size of 510928 MB (63866 extents from the Total PE value from the previous example multiplied by the 8 MB extent size).

```

# vgmodify -r -a -S 500m vg1
vgmodify: Error: Cannot reconfigure the volume group "/dev/vg1" to
the requested maximum volume group size 500 MB.
The maximum volume group size can be decreased
to a minimum of 510928 MB.
Physical volume "/dev/disk/disk46" was not changed.

```

```

vgmodify: Error: Cannot reconfigure the volume group "/dev/vg1" to
the requested maximum volume group size 500 MB.
The maximum volume group size can be decreased
to a minimum of 510928 MB.
Physical volume "/dev/disk/disk47" was not changed.

```

The desired (smaller) maximum VG size is too small.

2. Run `vgmodify` in review mode to verify you can decrease the maximum VG size from 256 TB to 64 TB.

```

# vgmodify -r -a -S 64t vg1
Physical volume "/dev/disk/disk46" requires reconfiguration to be
provisioned to the requested maximum volume group size 67108864 MB.
Current number of extents: 25533
Number of extents after reconfiguration: 25582
Physical volume "/dev/disk/disk46" was not changed.

```

```

Physical volume "/dev/disk/disk47" requires reconfiguration to be
provisioned to the requested maximum volume group size 67108864 MB.
Current number of extents: 38333
Number of extents after reconfiguration: 38382
Physical volume "/dev/disk/disk47" was not changed.

```

49 extents will be added to each PV.

3. Run `vgmodify` in change mode to decrease the maximum VG size to 64 TB.

```
# vgmodify -a -S 64t vg1
Reconfiguration of physical volume "/dev/disk/disk46" for the
requested maximum volume group size 67108864 MB succeeded.
Previous number of extents: 25533
Number of extents after reconfiguration: 25582
Physical volume "/dev/disk/disk46" was changed.
```

The maximum volume group size for `/dev/vg1` has been decreased from 268435456 MB to 67108864 MB.

Volume Group configuration for `/dev/vg1` has been saved in `/etc/lvmconf/vg1.conf`

```
Reconfiguration of physical volume "/dev/disk/disk47" for the
requested maximum volume group size 67108864 MB succeeded.
Previous number of extents: 38333
Number of extents after reconfiguration: 38382
Physical volume "/dev/disk/disk47" was changed.
```

Volume Group configuration for `/dev/vg1` has been saved in `/etc/lvmconf/vg1.conf`

4. Verify the results.

```
# vgdisplay -v vg1
--- Volume groups ---
VG Name                /dev/vg1
...
PE Size (Mbytes)       8
Total PE             63964
Alloc PE               51133
Free PE              12831
...
VG Version             2.1
VG Max Size          64t
VG Max Extents      8388608

--- Logical volumes ---
LV Name                /dev/vg1/lvol1
LV Status              available/syncd
LV Size (Mbytes)      409064
Current LE            51133
Allocated PE          51133
Used PV               2

--- Physical volumes ---
PV Name                /dev/disk/disk46
PV Status              available
Total PE             25582
Free PE              49
...

PV Name                /dev/disk/disk47
PV Status              available
Total PE             38382
Free PE              12782
```

LVM `vgmodify` Messages for Version 2.x volume groups

This section lists the messages reported by the `vgmodify` command on version 2.x volume groups. For additional information, see `vgmodify(1M)`.

- Physical volume `"/dev/disk/disk46"` requires reconfiguration for expansion.

In review mode, for a DLE operation, `vgmodify` reports that the physical volume was expanded by at least one extent, and that reconfiguration of the physical volume is required to make use of the extra space

- The physical volume `"/dev/disk/disk48"` does not need to be reconfigured for expansion since the available disk space is less than the size of one extent.

In review mode, or for a failed change mode, for a DLE operation, `vgmodify` reports that the physical volume size either has not changed, or has been expanded less than the size of one extent. Therefore, no reconfiguration is performed.

- Current number of extents: 12790
Number of extents after reconfiguration: 25590

In review mode, `vgmodify` reports that the reconfiguration will result in the number of extents for the physical volume being increased. The output might also report that the number of extents is staying the same, or being reduced.

- Previous number of extents: 12790
Number of extents after reconfiguration: 25590

In change mode, after successful reconfiguration of the physical volume, `vgmodify` reports that the number of extents for the physical volume was increased. It might also report that the number of extents stayed the same, or was reduced.

- Physical volume `"/dev/disk/disk46"` was not changed.

Either review mode, or change mode in which `vgmodify` did not detect that a reconfiguration was required.

- Physical volume `"/dev/disk/disk46"` was changed.

During a change mode operation, a physical volume was reconfigured.

- Reconfiguration to expand physical volume `"/dev/disk/disk46"` succeeded.

A DLE operation succeeded in reconfiguring a physical volume.

- Physical volume `"/dev/disk/disk46"` requires reconfiguration to be provisioned to the requested maximum volume group size 8388608 MB.

In review mode for either maximum VG size increase or decrease, `vgmodify` determined that the physical volume can be reconfigured to the requested size.

- Reconfiguration of physical volume `"/dev/disk/disk46"` for the requested maximum volume group size 8388608 MB succeeded.

In change mode for either maximum VG size increase or decrease, `vgmodify` successfully reconfigured the physical volume to the requested size.

- The physical volume `"/dev/disk/disk46"` can be reconfigured to the new maximum volume group size 3623256 MB without removing free extents from the end of the physical volume.

In either review mode, or for a failed change mode, for a maximum VG size increase, `vgmodify` reports the largest value that the maximum VG size can be increased to if no free extents are removed from the end of the physical volume.

- The physical volume `"/dev/disk/disk46"` can be reconfigured to the new maximum volume group size 268435456 MB by removing free extents from the end of the physical volume.

In either review mode, or for a failed change mode, for a maximum VG size increase, `vgmodify` reports the largest value that the maximum VG size can be increased to if free extents are removed from the end of the physical volume.

- The maximum volume group size for `"/dev/vg1"` has been increased from 512000 MB to 8388608 MB.

In change mode, for maximum VG size increase, when the last physical volume has been reconfigured, the maximum VG size, as displayed by `vgdisplay`, is changed to the requested value.

- `vgmodify`: Error: Cannot reconfigure physical volume `"/dev/disk/disk46"` to the requested maximum volume group size 134217728 MB without moving extent(s). The last 30 extent(s) have to be made free (see `pvmove(1M)`) to be able to reconfigure the physical volume.

In review mode, or for a failed change mode, for a maximum VG size increase, `vgmodify` reports that the reconfiguration of the physical volume cannot be performed unless in-use extents at the end of the physical volume are made free by using `pvmove` to relocate them. If the physical volume is expanded via DLE and the maximum VG size change is retried, it might not be necessary for `vgmodify` to remove free extents.

- The physical volume `"/dev/disk/disk48"` is already provisioned to the requested maximum vg size 268435456 MB The disk `/dev/rdisk/c2t4d0` was increased by a size less than the size of one physical extent.

In either review mode or change mode, `vgmodify` reports that no reconfiguration is needed for the maximum VG size increase or decrease since the physical volume is already configured to the requested size.

- `vgmodify`: Error: Cannot prepare physical volume `"/dev/disk/disk46"` for contraction to the requested size 204800 MB without moving extent(s). The last 25600 extent(s) have to be made free (see `pvmove(1M)`) to be able to prepare the physical volume for contraction.

In review mode, or for a failed change mode, for a DLC operation, `vgmodify` reports that the reconfiguration to prepare the physical volume for contraction cannot be performed unless in-use extents at the end of the physical volume are made free by using `pvmove` to relocate them.

- Physical volume `"/dev/rdisk/disk46"` requires reconfiguration for contraction to requested size 204800 MB.

In review mode, for a DLC operation, `vgmodify` reports that a physical volume can be prepared for contraction to the specified size.

- The physical volume `"/dev/rdisk/disk46"` can be reconfigured for contraction to a minimum size of 204793 MB by removing free extents from the end of the physical volume.

In review mode, or for failed change mode, for a DLC operation, `vgmodify` reports the smallest size that the physical volume can be contracted to if free extents at the end of physical volume are removed.

- The physical volume `"/dev/rdisk/disk46"` cannot be reconfigured for contraction to requested size 409599 MB since the amount being contracted is less than the size of one extent.

In review mode, or for failed change mode, for a DLC operation, `vgmodify` reports that the requested new PV size is less than one extent smaller than the previous PV size, so no reconfiguration is performed.

- Error: The requested contraction size 10 MB for physical volume `"/dev/rdisk/disk46"` is too small for reconfiguration to achieve.

In review mode, or for failed change mode, for a DLC operation, `vgmodify` reports that the requested new PV size is too small to achieve. The `vgmodify` does not allow a physical volume to be reduced down to zero extents (`vgmodify` retains at least one free extent). The minimum physical volume size depends on the configured extent size and the configured maximum VG size.

- Reconfiguration to contract physical volume `"/dev/rdisk/disk46"` to requested size 204800 MB succeeded.

In change mode, a DLC operation has succeeded in preparing a physical volume for contraction.

- `vgmodify`: Error: Cannot reconfigure the volume group `"/dev/vg1"` to the requested maximum volume group size 500 MB. The maximum volume group size can be decreased to a minimum of 510928 MB.

In review mode, or for a failed change mode, `vgmodify` reports that the specified maximum VG size decrease is too small to be achieved. The smallest that the maximum VG size can be decreased to is the current size of the VG.

- The maximum volume group size for `"/dev/vg1"` has been decreased from 268435456 MB to 67108864 MB.

In change mode, the volume group maximum VG size has been decreased to the requested value.

For More Information

To learn more about LVM and HP-UX system administration, refer to the following documents on the HP documentation website (<http://docs.hp.com>):

- *HP-UX System Administrator's Guide: Logical Volume Management*
<http://docs.hp.com/en/5992-4589/5992-4589.pdf>
- The LVM White Papers listed below are available at the HP documentation website:
<http://www.docs.hp.com/en/oshpux11iv3#LVM%20Volume%20Manager>
 - *LVM Limits*
 - *LVM Migration from Legacy to Agile Naming Model*
 - *LVM New Features in HP-UX 11i v3*
 - *LVM Online Disk Replacement (LVM OLR)*
 - *LVM Version 2.0 Volume Groups in HP-UX 11i v3*
 - *LVM Volume Group Quiesce/Resume*
 - *SLVM Single-Node Online Reconfiguration (SLVM SNOR)*

Call to action

HP welcomes your input. Please give us comments about this white paper, or suggestions for LVM or related documentation, through our technical documentation feedback website:

<http://docs.hp.com/en/feedback.html>