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# How to Extend the Default Ubuntu LVM Partition

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**POV:** You're a sysadmin who set up a one-off Linux machine for an app you needed, and now it's out of disk space.

You originally spun up a VM, installed a recent Ubuntu OS, and just hit *Next*, *Next*, *Finish* through the guided install. Linux is not your bread and butter, you usually deal in Windows, and you just need to get this done.

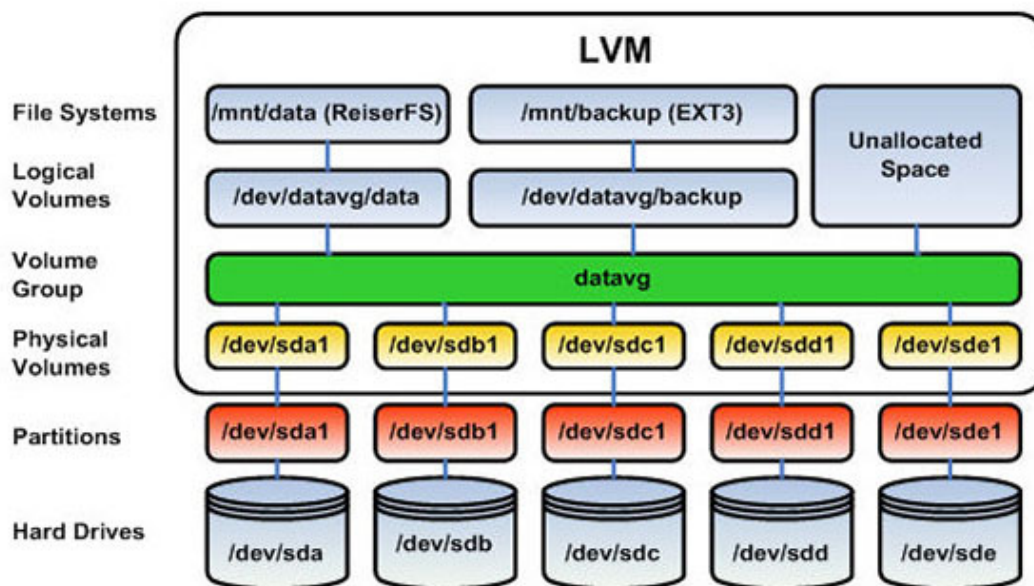
**Approx Reading Time:** 10 minutes

Note: In my examples, I'm using an "all-defaults" setup of **Ubuntu 20.04 Server** with a single **100GB disk**.

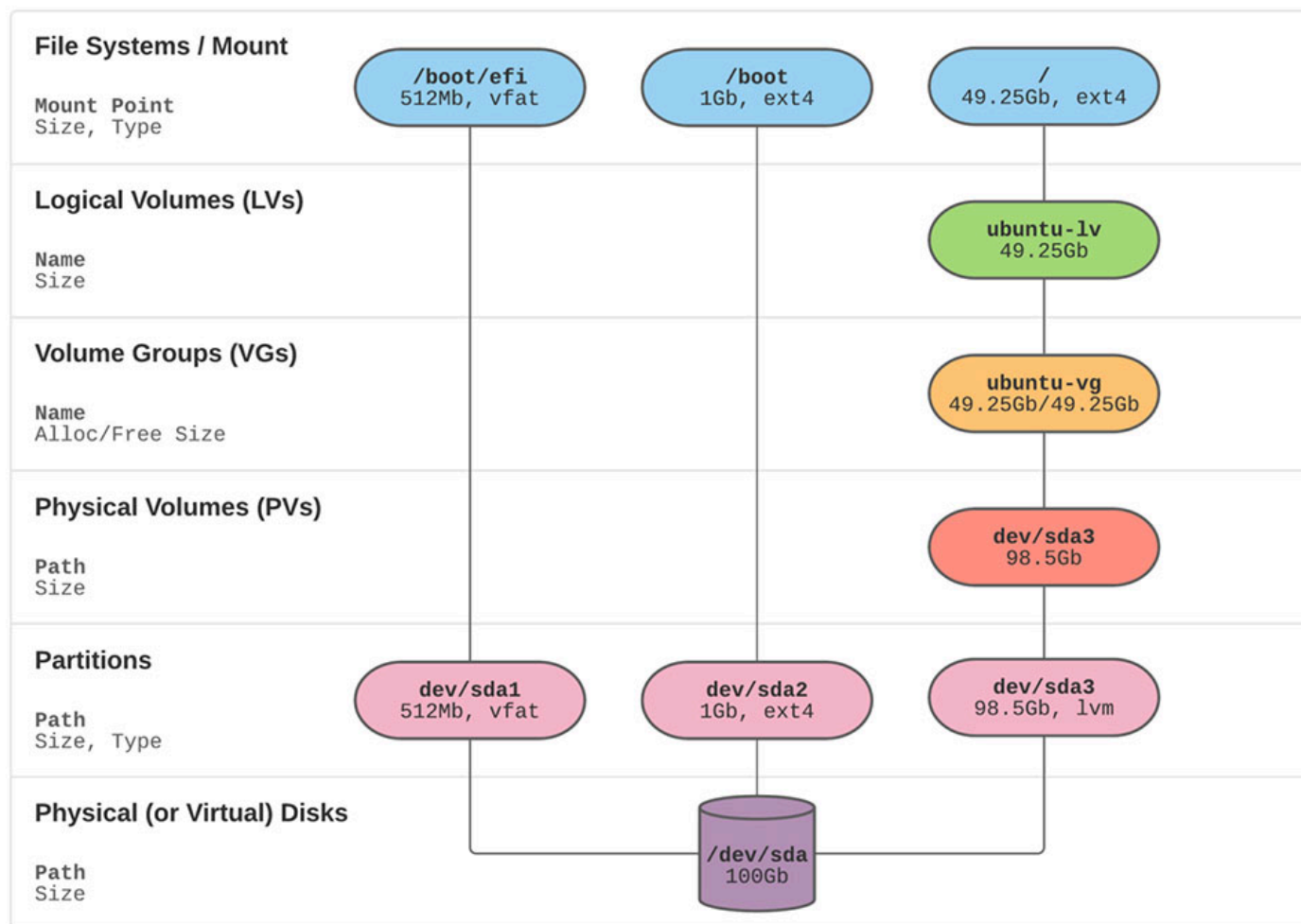
## Linux LVM Briefly Explained

If you followed the default settings in the Ubuntu installation, then the storage for your Linux OS is probably using the Logical Volume Manager (LVM). LVM is an abstraction framework which exists between your physical (or virtual) disks and your Linux file system (which is likely [ext4](https://en.wikipedia.org/wiki/Ext4) (<https://en.wikipedia.org/wiki/Ext4>)). It is used to group separate block devices (partitions) together into Volume Groups (VGs), and then chop those VGs up into logical block devices, or Logical Volumes (LVs). LVs are the abstracted block devices upon which your usable file system resides.

Below is a good visualization of how LVM works. In this example, we have five different disks, each with a single partition mapped to Physical Volumes (PVs), all being grouped into a single Volume Group (VG). The Volume Group is chopped up into two different Logical Volumes (LVs), and each LV is being used for a filesystem.



Using a similar visualization, the below diagram shows how the Ubuntu installer (using all default options) divided up my 100GB disk.



## Ubuntu Installer Default Settings

When installing Ubuntu, it has you approve a storage layout in a couple different screens (shown below). By default this storage layout will have a couple small boot partitions, and a third partition, which will be used by your LVM to create your root filesystem. You should be able to see the consistency between the screens below and the diagram above.

Configure a guided storage layout, or create a custom one:

☒ Use an entire disk

[ 360022480f626dcb39903386ec75175df local disk 100.000G ▼ ]

☒ Set up this disk as an LVM group

☐ Encrypt the LVM group with LUKS

Passphrase:

Confirm passphrase:

☐ Custom storage layout

#### FILE SYSTEM SUMMARY

MOUNT POINT	SIZE	TYPE	DEVICE	TYPE
[ /	49.248G	new ext4	new LVM logical volume	▶ ]
[ /boot	1.000G	new ext4	new partition of local disk	▶ ]
[ /boot/efi	512.000M	new fat32	new partition of local disk	▶ ]

#### AVAILABLE DEVICES

DEVICE	TYPE	SIZE
[ ubuntu-vg (new)	LVM volume group	98.496G ▶ ]
free space		49.248G
[ Create software RAID (md) ▶ ]		
[ Create volume group (LVM) ▶ ]		

#### USED DEVICES

DEVICE	TYPE	SIZE
[ ubuntu-vg (new)	LVM volume group	98.496G ▶ ]
ubuntu-lv	new, to be formatted as ext4, mounted at /	49.248G ▶
[ 360022480f626dcb39903386ec75175df	local disk	100.000G ▶ ]
partition 1	new, primary ESP, to be formatted as fat32, mounted at /boot/efi	512.000M ▶
partition 2	new, to be formatted as ext4, mounted at /boot	1.000G ▶
partition 3	new, PV of LVM volume group ubuntu-vg	98.496G ▶

# Use Your Default Free Space

As you can see above: the Ubuntu installer (by default) **left almost half of my disk space unusable by the root file system!** I've looked around to find an explanation on why these are the default settings, but can't find anything. Before extending your underlying hypervisor disk or storage volume, you may want to see if you have free space available and ready to be used to extend your existing file system. If you used the Ubuntu defaults during installation, then there is a good chance you have this free space.

Start by checking your root filesystem free space with `df -h`. As you can see I am only using **14%** of my **~49GB** volume, but we'll pretend I'm close to 100% and need to make that 49GB volume larger.

```
root@test:~# df -h
Filesystem                Size      Used Avail Use% Mounted on
udev                      1.9G         0   1.9G   0% /dev
tmpfs                     389M      900K   388M   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv 49G    6.3G    40G  14% /
tmpfs                     1.9G         0   1.9G   0% /dev/shm
tmpfs                     5.0M         0   5.0M   0% /run/lock
tmpfs                     1.9G         0   1.9G   0% /sys/fs/cgroup
/dev/loop0                56M       56M         0 100% /snap/core18/2128
/dev/loop1                71M       71M         0 100% /snap/lxd/21029
/dev/loop2                33M       33M         0 100% /snap/snapd/12704
/dev/sda2                 976M     107M    802M  12% /boot
/dev/sda1                 511M      5.3M    506M   2% /boot/efi
/dev/loop3                56M       56M         0 100% /snap/core18/2246
/dev/loop4                33M       33M         0 100% /snap/snapd/13640
/dev/loop5                62M       62M         0 100% /snap/core20/1169
tmpfs                     389M         0   389M   0% /run/user/0
/dev/loop6                68M       68M         0 100% /snap/lxd/21835
root@test:~#
```

To check for existing free space on your Volume Group (where it is left by the installer default settings), run the command `vgdisplay` and check for free space. Here you can see I have **49.25GB** of free space ready to be used. If you don't have any free space, move on to the next section to use some free space from an extended physical (or virtual) disk.

```
root@test:~# vgdisplay
--- Volume group ---
VG Name                   ubuntu-vg
System ID
Format                    lvm2
Metadata Areas            1
Metadata Sequence No     2
VG Access                 read/write
VG Status                 resizable
MAX LV                    0
Cur LV                   1
Open LV                   1
Max PV                    0
Cur PV                   1
Act PV                    1
VG Size                   <98.50 GiB
PE Size                   4.00 MiB
Total PE                  25215
Alloc PE / Size           12608 / 49.25 GiB
Free PE / Size             12607 / <49.25 GiB
VG UUID                   aawC0E-hjBV-B5FG-TvwM-5iM3-jcGa-3QU2zf
root@test:~#
```

To use up that free space on your Volume Group (VG) for your root Logical Volume (LV), first run the `lvdisplay` command and check the Logical Volume size, then run `lvextend -l +100%FREE /dev/ubuntu-vg/ubuntu-lv` to extend the LV to the maximum size usable, then run `lvdisplay` one more time to make sure it changed.

```

root@test:~# lvsdisplay
--- Logical volume ---
LV Path                /dev/ubuntu-vg/ubuntu-lv
LV Name                 ubuntu-lv
VG Name                 ubuntu-vg
LV UUID                 hIKHcl-VBar-e0w0-9cro-9Usa-pgYv-uanFOv
LV Write Access         read/write
LV Creation host, time  ubuntu-server, 2021-11-11 17:52:56 +0000
LV Status                available
# open                  1
LV Size                 49.25 GiB
Current LE              12608
Segments                1
Allocation               inherit
Read ahead sectors      auto
- currently set to      256
Block device            253:0

root@test:~#
root@test:~#
root@test:~# lvextend -l +100%FREE /dev/ubuntu-vg/ubuntu-lv
Size of logical volume ubuntu-vg/ubuntu-lv changed from 49.25 GiB (12608 exten.
Logical volume ubuntu-vg/ubuntu-lv successfully resized.
root@test:~#
root@test:~#
root@test:~# lvsdisplay
--- Logical volume ---
LV Path                /dev/ubuntu-vg/ubuntu-lv
LV Name                 ubuntu-lv
VG Name                 ubuntu-vg
LV UUID                 hIKHcl-VBar-e0w0-9cro-9Usa-pgYv-uanFOv
LV Write Access         read/write
LV Creation host, time  ubuntu-server, 2021-11-11 17:52:56 +0000
LV Status                available
# open                  1
LV Size                 <98.50 GiB
Current LE              25215
Segments                1
Allocation               inherit
Read ahead sectors      auto
- currently set to      256
Block device            253:0

root@test:~#

```

At this point you have increased the size of the block volume where your root filesystem resides, but you still need to extend the filesystem on top of it. First, run `df -h` to verify your (almost full) root file system, then run `resize2fs /dev/mapper/ubuntu-vg-ubuntu-lv` to extend your filesystem, and run `df -h` one more time to make sure you're successful.



```

root@test:~# df -h
Filesystem                Size      Used Avail Use% Mounted on
udev                     1.9G         0 1.9G   0% /dev
tmpfs                    389M       900K 388M   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv 49G    6.3G   40G  14% /
tmpfs                    1.9G         0 1.9G   0% /dev/shm
tmpfs                    5.0M         0 5.0M   0% /run/lock
tmpfs                    1.9G         0 1.9G   0% /sys/fs/cgroup
/dev/loop0               56M       56M   0 100% /snap/core18/2128
/dev/loop1              71M      71M   0 100% /snap/lxd/21029
/dev/loop2              33M      33M   0 100% /snap/snapd/12704
/dev/sda2               976M    107M  802M  12% /boot
/dev/sda1              511M    5.3M  506M   2% /boot/efi
/dev/loop3              56M       56M   0 100% /snap/core18/2246
/dev/loop4              33M      33M   0 100% /snap/snapd/13640
/dev/loop5              62M      62M   0 100% /snap/core20/1169
tmpfs                   389M         0 389M   0% /run/user/0
/dev/loop6              68M      68M   0 100% /snap/lxd/21835

root@test:~#
root@test:~#
root@test:~# resize2fs /dev/mapper/ubuntu--vg-ubuntu--lv
resize2fs 1.45.5 (07-Jan-2020)
Filesystem at /dev/mapper/ubuntu--vg-ubuntu--lv is mounted on /; on-line resizing
old_desc_blocks = 7, new_desc_blocks = 13
The filesystem on /dev/mapper/ubuntu--vg-ubuntu--lv is now 25820160 (4k) blocks.

root@test:~#
root@test:~#
root@test:~# df -h
Filesystem                Size      Used Avail Use% Mounted on
udev                     1.9G         0 1.9G   0% /dev
tmpfs                    389M       900K 388M   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv 97G    6.3G   87G   7% /
tmpfs                    1.9G         0 1.9G   0% /dev/shm
tmpfs                    5.0M         0 5.0M   0% /run/lock
tmpfs                    1.9G         0 1.9G   0% /sys/fs/cgroup
/dev/loop0               56M       56M   0 100% /snap/core18/2128
/dev/loop1              71M      71M   0 100% /snap/lxd/21029
/dev/loop2              33M      33M   0 100% /snap/snapd/12704
/dev/sda2               976M    107M  802M  12% /boot
/dev/sda1              511M    5.3M  506M   2% /boot/efi
/dev/loop3              56M       56M   0 100% /snap/core18/2246
/dev/loop4              33M      33M   0 100% /snap/snapd/13640
/dev/loop5              62M      62M   0 100% /snap/core20/1169
tmpfs                   389M         0 389M   0% /run/user/0
/dev/loop6              68M      68M   0 100% /snap/lxd/21835

root@test:~#

```

And that's it. You just allocated the free space left behind by the Ubuntu installer to your root filesystem. If this is still not enough space, continue on to the next section to allocate more space by extending an underlying disk.

## Use Space from Extended Physical (or Virtual) Disk

First you need to increase the size of the disk being presented to the Linux OS. This is most likely done by expanding the virtual disk in KVM/VMWare/Hyper-V or by adjusting your RAID controller / storage system to increase the volume size. You can often do this while Linux is running; without shutting down or restarting. I've extended my **100GB** disk to **200GB** for my example machine.

Once that is done, you may need to get Linux to rescan the disk for the new free space. Check for free space by running `cfdisk` and see if there is free space listed, use "q" to exit once you're done.

```

Disk: /dev/sda
Size: 100 GiB, 107374182400 bytes, 209715200 sectors
Label: gpt, identifier: 7C00EE2F-9E6E-4CE5-BDE6-2FC8D99412D6

Device      Start      End      Sectors   Size Type
/dev/sda1    2048      1050623  1048576   512M EFI System
/dev/sda2    1050624   3147775  2097152   1G Linux filesystem
>> /dev/sda3  3147776   209713151 206565376 98.5G Linux filesystem

Partition UUID: CD94AE21-BA11-45A0-84C3-008E007D9057
Partition type: Linux filesystem (0FC63DAF-8483-4772-8E79-3D69D8477DE4)
Filesystem UUID: sL0bD6-1Y5z-Y0lx-co9O-zNBz-rV7j-xWuiJk
Filesystem: LVM2_member

[ Delete ] [ Resize ] [ Quit ] [ Type ] [ Help ] [ Write ] [ Dump ]

```

If you don't see free space listed, then initiate a rescan of /dev/sda with echo 1>/sys/class/block/sda/device/rescan. Once done, rerun cfdisk and you should see the free space listed.

```

Disk: /dev/sda
Size: 200 GiB, 214748364800 bytes, 419430400 sectors
Label: gpt, identifier: 7C00EE2F-9E6E-4CE5-BDE6-2FC8D99412D6

Device      Start      End      Sectors   Size Type
>> /dev/sda1    2048      1050623  1048576   512M EFI System
/dev/sda2    1050624   3147775  2097152   1G Linux filesystem
/dev/sda3    3147776   209713151 206565376 98.5G Linux filesystem
Free space   209713152  419430366 209717215 100G

Partition UUID: 8F1A4C8B-DE4D-4780-B068-52686E8F997F
Partition type: EFI System (C12A7328-F81F-11D2-BA4B-00A0C93EC93B)
Filesystem UUID: 8722-3C16
Filesystem: vfat
Mountpoint: /boot/efi (mounted)

[ Delete ] [ Resize ] [ Quit ] [ Type ] [ Help ] [ Write ] [ Dump ]

```

Select your /dev/sda3 partition from the list and then select “**Resize**” from the bottom menu. Hit **ENTER** and it will prompt you to confirm the new size. Hit **ENTER** again and you will now see the /dev/sda3 partition with a new larger size.

Select “**Write**” from the bottom menu, type **yes** to confirm, and hit **ENTER**. Then use “**q**” to exit the program.

Now that the LVM partition backing the /dev/sda3 Physical Volume (PV) has been extended, we need to extend the PV itself. Run pvresize /dev/sda3 to do this and then use pvdisplay to check the new size.

```

root@test:~# pvresize /dev/sda3
Physical volume "/dev/sda3" changed
1 physical volume(s) resized or updated / 0 physical volume(s) not resized
root@test:~#
root@test:~#
root@test:~#
root@test:~#
root@test:~# pvdisk
--- Physical volume ---
PV Name                /dev/sda3
VG Name                ubuntu-vg
PV Size                <198.50 GiB / not usable 1.98 MiB
Allocatable            yes
PE Size                4.00 MiB
Total PE               50815
Free PE                25600
Allocated PE           25215
PV UUID                sL0bD6-1Y5z-YOlX-co9O-zNBz-rV7j-xWuiJk
root@test:~#

```

As you can see above, my PV has been increased from 98.5GB to 198.5GB. Now let's check the Volume Group (VG) free space with vgdisplay.

```

root@test:~# vgdisplay
--- Volume group ---
VG Name                ubuntu-vg
System ID
Format                lvm2
Metadata Areas         1
Metadata Sequence No   4
VG Access              read/write
VG Status              resizable
MAX LV                 0
Cur LV                1
Open LV                1
Max PV                 0
Cur PV                1
Act PV                 1
VG Size                <198.50 GiB
PE Size                4.00 MiB
Total PE               50815
Alloc PE / Size        25215 / <98.50 GiB
Free PE / Size         25600 / 100.00 GiB
VG UUID                aawC0E-hjBV-B5FG-TvwM-5iM3-jcGa-3QU2zf
root@test:~#

```

We can see above that the VG has 100GB of free space. Now let's check the size of our upstream Logical Volume (LV) using lvdisplay, extend the LV to use up all the VG's free space with lvextend -l +100%FREE /dev/ubuntu-vg/ubuntu-lv, and then check the LV one more time with lvdisplay to make sure it has been extended.



```

root@test:~# lvsdisplay
--- Logical volume ---
LV Path                /dev/ubuntu-vg/ubuntu-lv
LV Name                 ubuntu-lv
VG Name                 ubuntu-vg
LV UUID                 hIKHcl-VBar-e0w0-9cro-9Usa-pgYv-uanFOv
LV Write Access         read/write
LV Creation host, time  ubuntu-server, 2021-11-11 17:52:56 +0000
LV Status                available
# open                  1
LV Size                  <98.50 GiB
Current LE               25215
Segments                1
Allocation               inherit
Read ahead sectors      auto
- currently set to      256
Block device             253:0

root@test:~#
root@test:~#
root@test:~# lvextend -l +100%FREE /dev/ubuntu-vg/ubuntu-lv
Size of logical volume ubuntu-vg/ubuntu-lv changed from <98.50 GiB (25215 exte.
Logical volume ubuntu-vg/ubuntu-lv successfully resized.
root@test:~#
root@test:~#
root@test:~# lvsdisplay
--- Logical volume ---
LV Path                /dev/ubuntu-vg/ubuntu-lv
LV Name                 ubuntu-lv
VG Name                 ubuntu-vg
LV UUID                 hIKHcl-VBar-e0w0-9cro-9Usa-pgYv-uanFOv
LV Write Access         read/write
LV Creation host, time  ubuntu-server, 2021-11-11 17:52:56 +0000
LV Status                available
# open                  1
LV Size                  <198.50 GiB
Current LE               50815
Segments                1
Allocation               inherit
Read ahead sectors      auto
- currently set to      256
Block device             253:0

root@test:~#

```

At this point, the block volume underpinning our root filesystem has been extended, but the filesystem itself has not been resized to fit that new volume. To do this, run `df -h` to check the current size of the file system, then run `resize2fs /dev/mapper/ubuntu-vg-ubuntu-lv` to resize it, and `df -h` one more time to check the new file system available space.

```

root@test:~# df -h
Filesystem                Size      Used Avail Use% Mounted on
udev                     1.9G         0   1.9G   0% /dev
tmpfs                    389M       896K   388M   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv  97G       6.3G    87G   7% /
tmpfs                    1.9G         0   1.9G   0% /dev/shm
tmpfs                    5.0M         0   5.0M   0% /run/lock
tmpfs                    1.9G         0   1.9G   0% /sys/fs/cgroup
/dev/loop0               56M       56M         0 100% /snap/core18/2128
/dev/loop1               56M       56M         0 100% /snap/core18/2246
/dev/loop2               33M       33M         0 100% /snap/snapd/13640
/dev/loop3               33M       33M         0 100% /snap/snapd/12704
/dev/loop4               71M       71M         0 100% /snap/lxd/21029
/dev/loop5               62M       62M         0 100% /snap/core20/1169
/dev/loop6               68M       68M         0 100% /snap/lxd/21835
/dev/sda2                976M     107M    802M  12% /boot
/dev/sda1                511M      5.3M    506M   2% /boot/efi
tmpfs                    389M         0   389M   0% /run/user/0

root@test:~#
root@test:~#
root@test:~# resize2fs /dev/mapper/ubuntu--vg-ubuntu--lv
resize2fs 1.45.5 (07-Jan-2020)
Filesystem at /dev/mapper/ubuntu--vg-ubuntu--lv is mounted on /; on-line resizing
old_desc_blocks = 13, new_desc_blocks = 25
The filesystem on /dev/mapper/ubuntu--vg-ubuntu--lv is now 52034560 (4k) blocks.

root@test:~#
root@test:~#
root@test:~# df -h
Filesystem                Size      Used Avail Use% Mounted on
udev                     1.9G         0   1.9G   0% /dev
tmpfs                    389M       896K   388M   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv  196G       6.3G   181G   4% /
tmpfs                    1.9G         0   1.9G   0% /dev/shm
tmpfs                    5.0M         0   5.0M   0% /run/lock
tmpfs                    1.9G         0   1.9G   0% /sys/fs/cgroup
/dev/loop0               56M       56M         0 100% /snap/core18/2128
/dev/loop1               56M       56M         0 100% /snap/core18/2246
/dev/loop2               33M       33M         0 100% /snap/snapd/13640
/dev/loop3               33M       33M         0 100% /snap/snapd/12704
/dev/loop4               71M       71M         0 100% /snap/lxd/21029
/dev/loop5               62M       62M         0 100% /snap/core20/1169
/dev/loop6               68M       68M         0 100% /snap/lxd/21835
/dev/sda2                976M     107M    802M  12% /boot
/dev/sda1                511M      5.3M    506M   2% /boot/efi
tmpfs                    389M         0   389M   0% /run/user/0

root@test:~#

```

And there you go. You've now taken an expanded physical (or virtual) disk and moved that free space all the way up through the LVM [abstraction layers](https://packetpushers.net/podcast/day-two-cloud-081-abstractions-should-save-typing-not-thinking/) (<https://packetpushers.net/podcast/day-two-cloud-081-abstractions-should-save-typing-not-thinking/>) to be used by your (critically full) root file system. Time to check it off the to-do list and move on to the next IT emergency.

**About John W Kerns:** John Kerns is a network and automation engineer for a VAR based in Southern California and has been in the industry for over 12 years. He maintains a few open-source projects on GitHub and writes for Packet Pushers.

[GITHUB \(HTTPS://GITHUB.COM/PACKETSAR/\)](https://github.com/packetsar/)

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