Thin Provisioning Volume in LVM

1. Check system IP-

```
[root@client1 ~]# ifconfig
ens160: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.78.146  netmask 255.255.255.0  broadcast 192.168.78.255
```

2. Add a hard disk of 50GB & verify it-

```
[root@client1 ~]# lsblk
NAME          MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda             8:0    0   10G  0 disk
sdb             8:16   0   10G  0 disk
├─sdb1          8:17   0    1G  0 part
├─sdb2          8:18   0    1G  0 part
└─sdb3          8:19   0    1G  0 part [SWAP]
sdc             8:32   0   50G  0 disk
sr0            11:0    1 1024M  0 rom
nvme0n1       259:0    0   60G  0 disk
├─nvme0n1p1   259:1    0    1G  0 part /boot
└─nvme0n1p2   259:2    0   59G  0 part
  ├─rhel-root 253:0    0 38.3G  0 lvm  /
  ├─rhel-swap 253:1    0    2G  0 lvm  [SWAP]
  └─rhel-home 253:2    0 18.7G  0 lvm  /home
```

3. Create a partition “sdc1” of 30GB in disk “sdc” & run partprobe to let kernel know about it-

```
[root@client1 ~]# fdisk /dev/sdc

Welcome to fdisk (util-linux 2.37.4).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Device does not contain a recognized partition table.
Created a new DOS disklabel with disk identifier 0x517b3b6a.

Command (m for help): n
Partition type
   p   primary (0 primary, 0 extended, 4 free)
   e   extended (container for logical partitions)
Select (default p): p
Partition number (1-4, default 1): 1
First sector (2048-104857599, default 2048):
Last sector, +/-sectors or +/-size{K,M,G,T,P} (2048-104857599, default 104857599): +20G

Created a new partition 1 of type 'Linux' and of size 20 GiB.

Command (m for help): w
The partition table has been altered.
Calling ioctl() to re-read partition table.
Syncing disks.

[root@client1 ~]# partprobe /dev/sdc
```

4. Verify this newly created partition-

```
[root@client1 ~]# lsblk
NAME          MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda             8:0    0   10G  0 disk
sdb             8:16   0   10G  0 disk
├─sdb1          8:17   0    1G  0 part
├─sdb2          8:18   0    1G  0 part
└─sdb3          8:19   0    1G  0 part [SWAP]
sdc             8:32   0   50G  0 disk
└─sdc1          8:33   0   20G  0 part
sr0            11:0    1 1024M  0 rom
```

5. Create physical volume using this partition-

```
[root@client1 ~]# pvcreate /dev/sdc1
  Physical volume "/dev/sdc1" successfully created.
[root@client1 ~]#
```

6. Create a volume group with 32MB physical extent using this physical volume-

```
[root@client1 ~]# vgcreate -s 32M vg_thin /dev/sdc1
  Volume group "vg_thin" successfully created
[root@client1 ~]#
```

7. Verify whether this newly created volume group has 32MB PE (Physical Extent)-

```
[root@client1 ~]# vgdisplay vg_thin
  --- Volume group ---
  VG Name               vg_thin
  System ID
  Format                lvm2
  Metadata Areas        1
  Metadata Sequence No  1
  VG Access             read/write
  VG Status             resizable
  MAX LV                0
  Cur LV                0
  Open LV               0
  Max PV                0
  Cur PV                1
  Act PV                1
  VG Size               <19.97 GiB
  PE Size               32.00 MiB
  Total PE              639
  Alloc PE / Size       0 / 0
  Free  PE / Size       639 / <19.97 GiB
  VG UUID               1KzXo7-tMLQ-AdcA-JtOK-SeL6-CH1p-w1qcV5
```

8. Next, create a thin pool using this volume group. It will be used for allocating space to logical volume which will be created in future-

```
[root@client1 ~]# lvcreate -L 15G --thinpool tp_cricbuzz_pool vg_thin
  Thin pool volume with chunk size 64.00 KiB can address at most <15.88 TiB of data.
  Logical volume "tp_cricbuzz_pool" created.
[root@client1 ~]#
```

9. Verify this thin pool-

```
[root@client1 ~]# lvs
  LV              VG      Attr       LSize  Pool Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home            rhel    -wi-ao---- 18.69g
  root            rhel    -wi-ao---- 38.28g
  swap            rhel    -wi-ao----  2.02g
  tp_cricbuzz_pool vg_thin twi-a-tz-- 15.00g             0.00   10.29
[root@client1 ~]#
```

Here, ‘t’ stands for thin provisioning.

10. We will confirm the same using lsblk-

```
[root@client1 ~]# lsblk
NAME                                MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda                                   8:0    0   10G  0 disk
sdb                                   8:16   0   10G  0 disk
├─sdb1                                8:17   0    1G  0 part
├─sdb2                                8:18   0    1G  0 part
└─sdb3                                8:19   0    1G  0 part [SWAP]
sdc                                   8:32   0   50G  0 disk
└─sdc1                                8:33   0   20G  0 part
  ├─vg_thin-tp_cricbuzz_pool_tmeta  253:3    0   32M  0 lvm
  │ └─vg_thin-tp_cricbuzz_pool      253:5    0   15G  0 lvm
  └─vg_thin-tp_cricbuzz_pool_tdata  253:4    0   15G  0 lvm
    └─vg_thin-tp_cricbuzz_pool      253:5    0   15G  0 lvm
sr0                                  11:0    1 1024M  0 rom
```

It shows this pool created.

11. To get more detail about this thin pool use command shown below-

```
[root@client1 ~]# lvdisplay vg_thin/tp_cricbuzz_pool
  --- Logical volume ---
  LV Name                tp_cricbuzz_pool
  VG Name                vg_thin
  LV UUID                h16e11-5d3p-zf2V-08Yc-gP34-js0j-S8fjkd
  LV Write Access        read/write
  LV Creation host, time client1.cricbuzz.com, 2022-12-23 21:22:20 +0530
  LV Pool metadata       tp_cricbuzz_pool_tmeta
  LV Pool data           tp_cricbuzz_pool_tdata
  LV Status              available
  # open                 0
  LV Size                15.00 GiB
  Allocated pool data    0.00%
  Allocated metadata     10.29%
  Current LE             480
  Segments               1
  Allocation             inherit
  Read ahead sectors     auto
  - currently set to     256
  Block device           253:5
```

12. Now, we will create logical volume from the space of thin pool & verify it-

```
[root@client1 ~]# lvcreate -V 5G --thin -n thin_vol_client1 vg_thin/tp_cricbuzz_pool
  Logical volume "thin_vol_client1" created.
[root@client1 ~]#
```

```
[root@client1 ~]# lvs
  LV              VG      Attr       LSize  Pool            Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home            rhel    -wi-ao---- 18.69g
  root            rhel    -wi-ao---- 38.28g
  swap            rhel    -wi-ao----  2.02g
  thin_vol_client1 vg_thin Vwi-a-tz--  5.00g tp_cricbuzz_pool        0.00
  tp_cricbuzz_pool vg_thin twi-aotz-- 15.00g                        0.00   10.30
```

Now thin pool will have 10GB space available to allocate for other future logical volumes.

13. We will create two more logical volume as shown & verify it-

```
[root@client1 ~]# lvcreate -V 5G --thin -n thin_vol_client2 vg_thin/tp_cricbuzz_pool
  Logical volume "thin_vol_client2" created.
[root@client1 ~]#
[root@client1 ~]#
[root@client1 ~]# lvs
  LV               VG      Attr       LSize  Pool             Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home             rhel    -wi-ao---- 18.69g
  root             rhel    -wi-ao---- 38.28g
  swap             rhel    -wi-ao----  2.02g
  thin_vol_client1 vg_thin Vwi-a-tz--  5.00g tp_cricbuzz_pool        0.00
  thin_vol_client2 vg_thin Vwi-a-tz--  5.00g tp_cricbuzz_pool        0.00
  tp_cricbuzz_pool vg_thin twi-aotz-- 15.00g                        0.00   10.31
```

```
[root@client1 ~]# lvcreate -V 5G --thin -n thin_vol_client3 vg_thin/tp_cricbuzz_pool
  Logical volume "thin_vol_client3" created.
[root@client1 ~]#
[root@client1 ~]#
[root@client1 ~]# lvs
  LV               VG      Attr       LSize  Pool             Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home             rhel    -wi-ao---- 18.69g
  root             rhel    -wi-ao---- 38.28g
  swap             rhel    -wi-ao----  2.02g
  thin_vol_client1 vg_thin Vwi-a-tz--  5.00g tp_cricbuzz_pool        0.00
  thin_vol_client2 vg_thin Vwi-a-tz--  5.00g tp_cricbuzz_pool        0.00
  thin_vol_client3 vg_thin Vwi-a-tz--  5.00g tp_cricbuzz_pool        0.00
  tp_cricbuzz_pool vg_thin twi-aotz-- 15.00g                        0.00   10.33
[root@client1 ~]#
```

14. We will create three directories inside /mnt to mount these three LV-

```
[root@client1 ~]# mkdir -p /mnt/client1 /mnt/client2 /mnt/client3
[root@client1 ~]#
[root@client1 ~]# ls -ll /mnt/
total 4
drwxr-xr-x. 2 root root    6 Dec 23 21:31 client1
drwxr-xr-x. 2 root root    6 Dec 23 21:31 client2
drwxr-xr-x. 2 root root    6 Dec 23 21:31 client3
```

15. Next, we will format these LVs using ext4 file system. We will use '&&' operator to do this at once-

```
[root@client1 ~]# mkfs.ext4 /dev/vg_thin/thin_vol_client1 && mkfs.ext4 /dev/vg_thin/thin_vol_client2 && mkfs.ext4 /dev/vg_thin/thin_vol_client3
mke2fs 1.46.5 (30-Dec-2021)
Discarding device blocks: done
Creating filesystem with 1310720 4k blocks and 327680 inodes
Filesystem UUID: c0431527-f97b-410c-b886-4049af03da46
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736

Allocating group tables: done
Writing inode tables: done
Creating journal (16384 blocks): done
Writing superblocks and filesystem accounting information: done

mke2fs 1.46.5 (30-Dec-2021)
Discarding device blocks: done
Creating filesystem with 1310720 4k blocks and 327680 inodes
Filesystem UUID: d7755cc4-e3a6-4013-8d66-77739e91adaf
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736

Allocating group tables: done
Writing inode tables: done
Creating journal (16384 blocks): done
Writing superblocks and filesystem accounting information: done

mke2fs 1.46.5 (30-Dec-2021)
Discarding device blocks: done
Creating filesystem with 1310720 4k blocks and 327680 inodes
Filesystem UUID: ffdb0df3-8fc3-457f-a660-e58a833597df
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736

Allocating group tables: done
Writing inode tables: done
Creating journal (16384 blocks): done
Writing superblocks and filesystem accounting information: done
```

16. Verify these formatted LVs-

```
[root@client1 ~]# lsblk -f
NAME                                FSTYPE      FSVER    LABEL UUID                                   FSAVAIL FSUSE% MOUNTPOINTS
sda
sdb
├─sdb1                              xfs                       6e1fc73d-9d86-4436-9601-36780f7f146a
├─sdb2                              ext4        1.0           33ef26c5-8e62-48e4-8813-bab78228032f
└─sdb3                              swap        1             4e6c60b3-d2d5-4e9a-bf48-907cdc6e2946                [SWAP]
sdc
└─sdc1                              LVM2_member LVM2 001      AI7RHq-pk9W-gfpu-Cubw-kghB-gVPo-seT5YD
  ├─vg_thin-tp_cricbuzz_pool_tmeta
  │ └─vg_thin-tp_cricbuzz_pool-tpool
  │   ├─vg_thin-tp_cricbuzz_pool
  │   ├─vg_thin-thin_vol_client1    ext4        1.0           c0431527-f97b-410c-b886-4049af03da46
  │   ├─vg_thin-thin_vol_client2    ext4        1.0           d7755cc4-e3a6-4013-8d66-77739e91adaf
  │   └─vg_thin-thin_vol_client3    ext4        1.0           ffdb0df3-8fc3-457f-a660-e58a833597df
  └─vg_thin-tp_cricbuzz_pool_tdata
    └─vg_thin-tp_cricbuzz_pool-tpool
      ├─vg_thin-tp_cricbuzz_pool
      ├─vg_thin-thin_vol_client1    ext4        1.0           c0431527-f97b-410c-b886-4049af03da46
      ├─vg_thin-thin_vol_client2    ext4        1.0           d7755cc4-e3a6-4013-8d66-77739e91adaf
      └─vg_thin-thin_vol_client3    ext4        1.0           ffdb0df3-8fc3-457f-a660-e58a833597df
sr0
```

17. We will mount these LVs to the directory created earlier-

```
[root@client1 ~]# mount /dev/vg_thin/thin_vol_client1 /mnt/client1 && mount /dev/vg_thin/thin_vol_client2 /mnt/client2 && mount /dev/vg_thin/thin_vol_client3 /mnt/client3
[root@client1 ~]#
[root@client1 ~]#
[root@client1 ~]#
[root@client1 ~]# df -Th
Filesystem                          Type      Size  Used Avail Use% Mounted on
devtmpfs                            devtmpfs  3.8G     0  3.8G   0% /dev
tmpfs                               tmpfs     3.8G     0  3.8G   0% /dev/shm
tmpfs                               tmpfs     1.5G  9.8M  1.5G   1% /run
/dev/mapper/rhel-root               xfs        39G   23G   16G  59% /
/dev/nvme0n1p1                      xfs      1014M  221M  794M  22% /boot
/dev/mapper/rhel-home               xfs        19G  345M   19G   2% /home
tmpfs                               tmpfs     766M   52K  766M   1% /run/user/42
tmpfs                               tmpfs     766M   36K  766M   1% /run/user/0
/dev/mapper/vg_thin-thin_vol_client1 ext4     4.9G   24K  4.6G   1% /mnt/client1
/dev/mapper/vg_thin-thin_vol_client2 ext4     4.9G   24K  4.6G   1% /mnt/client2
/dev/mapper/vg_thin-thin_vol_client3 ext4     4.9G   24K  4.6G   1% /mnt/client3
[root@client1 ~]#
```

18. Go to /mnt/client1 & add file of 2GB in size-

```
[root@client1 ~]# cd /mnt/client1/
[root@client1 client1]# ls -ll
total 16
drwx------. 2 root root 16384 Dec 23 21:33 lost+found
[root@client1 client1]#
```

```
[root@client1 client1]# dd if=/dev/zero of=/mnt/client1/secret.txt bs=1024M count=2
2+0 records in
2+0 records out
2147483648 bytes (2.1 GB, 2.0 GiB) copied, 16.4895 s, 130 MB/s
[root@client1 client1]#
[root@client1 client1]#
[root@client1 client1]# ls -lh
total 2.1G
drwx------. 2 root root  16K Dec 23 21:33 lost+found
-rw-r--r--. 1 root root 2.0G Dec 23 21:43 secret.txt
[root@client1 client1]#
```

19. Check total space utilized (See Data% column) by the LV & show same for thin pool-

```
[root@client1 client1]# lvs
  LV              VG      Attr       LSize  Pool            Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home            rhel    -wi-ao---- 18.69g
  root            rhel    -wi-ao---- 38.28g
  swap            rhel    -wi-ao----  2.02g
  thin_vol_client1 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        32.05
  thin_vol_client2 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        2.88
  thin_vol_client3 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        2.88
  tp_cricbuzz_pool vg_thin twi-aotz-- 15.00g                        12.60  12.51
```

20. Do the same for /mnt/client2-

```
[root@client1 client1]# cd /mnt/client2/
[root@client1 client2]#
```

```
[root@client1 client2]# dd if=/dev/zero of=/mnt/client2/secret.txt bs=1024M count=2
2+0 records in
2+0 records out
2147483648 bytes (2.1 GB, 2.0 GiB) copied, 12.3501 s, 174 MB/s
[root@client1 client2]#
[root@client1 client2]#
[root@client1 client2]# ls -lh
total 2.1G
drwx------. 2 root root  16K Dec 23 21:33 lost+found
-rw-r--r--. 1 root root 2.0G Dec 23 21:44 secret.txt
[root@client1 client2]#
```

```
[root@client1 client2]# lvs
  LV              VG      Attr       LSize  Pool            Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home            rhel    -wi-ao---- 18.69g
  root            rhel    -wi-ao---- 38.28g
  swap            rhel    -wi-ao----  2.02g
  thin_vol_client1 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        82.88
  thin_vol_client2 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        42.88
  thin_vol_client3 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        2.88
  tp_cricbuzz_pool vg_thin twi-aotz-- 15.00g                        42.88  17.63
[root@client1 client2]#
```

21. In the same way, do for /mnt/client3-

```
[root@client1 client2]# cd /mnt/client3/
[root@client1 client3]#
[root@client1 client3]# dd if=/dev/zero of=/mnt/client3/secret.txt bs=1024M count=2
2+0 records in
2+0 records out
2147483648 bytes (2.1 GB, 2.0 GiB) copied, 7.69164 s, 279 MB/s
[root@client1 client3]#
[root@client1 client3]#
[root@client1 client3]# ls -lh
total 2.1G
drwx------. 2 root root  16K Dec 23 21:33 lost+found
-rw-r--r--. 1 root root 2.0G Dec 23 21:46 secret.txt
[root@client1 client3]#
```

```
[root@client1 client3]# lvs
  LV              VG      Attr       LSize  Pool            Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home            rhel    -wi-ao---- 18.69g
  root            rhel    -wi-ao---- 38.28g
  swap            rhel    -wi-ao----  2.02g
  thin_vol_client1 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        82.88
  thin_vol_client2 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        42.88
  thin_vol_client3 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        42.88
  tp_cricbuzz_pool vg_thin twi-aotz-- 15.00g                        56.21  20.01
[root@client1 client3]#
```

22. Now, we want to add another LV of 5GB using thin pool space. In normal LVM case, it won't allow us to create another LV as pool space is completely assigned to three LVs. But in case of thin provisioning, we can do that. It will take unused space from the already created LVs & used them to allocate space to new LV. It is risky as well, cause once other LVs space is utilized by themselves, data will get corrupted. So, we always have to monitor pool space. It should not be completely utilized.

```
[root@client1 client3]# lvcreate -V 5G --thin -n thin_vol_client4 vg_thin/tp_cricbuzz_pool
  WARNING: Sum of all thin volume sizes (20.00 GiB) exceeds the size of thin pool vg_thin/tp_cricbuzz_pool and the size of whole volume group (<19.97 GiB).
  WARNING: You have not turned on protection against thin pools running out of space.
  WARNING: Set activation/thin_pool_autoextend_threshold below 100 to trigger automatic extension of thin pools before they get full.
  Logical volume "thin_vol_client4" created.
[root@client1 client3]#
[root@client1 client3]#
[root@client1 client3]# lvs
  LV              VG      Attr       LSize  Pool            Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home            rhel    -wi-ao---- 18.69g
  root            rhel    -wi-ao---- 38.28g
  swap            rhel    -wi-ao----  2.02g
  thin_vol_client1 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        82.88
  thin_vol_client2 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        42.88
  thin_vol_client3 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        42.88
  thin_vol_client4 vg_thin Vwi-a-tz--  5.00g tp_cricbuzz_pool        0.00
  tp_cricbuzz_pool vg_thin twi-aotz-- 15.00g                        56.21  20.02
[root@client1 client3]#
```

Currently, space utilization for pool is 56.21%. We can see the warning message. Here, we will format this newly created LV using ext4 & mount it on /mnt/client4. For that, first we need to create this directory.

23. Verify this newly created LV using lsblk-

```
[root@client1 client3]# lsblk
NAME                                    MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda                                       8:0    0   10G  0 disk
sdb                                       8:16   0   10G  0 disk
├─sdb1                                    8:17   0    1G  0 part
├─sdb2                                    8:18   0    1G  0 part
└─sdb3                                    8:19   0    1G  0 part [SWAP]
sdc                                       8:32   0   50G  0 disk
└─sdc1                                    8:33   0   20G  0 part
  ├─vg_thin-tp_cricbuzz_pool_tmeta      253:3    0   32M  0 lvm
  │ └─vg_thin-tp_cricbuzz_pool-tpool    253:5    0   15G  0 lvm
  │   ├─vg_thin-tp_cricbuzz_pool        253:6    0   15G  1 lvm
  │   ├─vg_thin-thin_vol_client1        253:7    0    5G  0 lvm  /mnt/client1
  │   ├─vg_thin-thin_vol_client2        253:8    0    5G  0 lvm  /mnt/client2
  │   ├─vg_thin-thin_vol_client3        253:9    0    5G  0 lvm  /mnt/client3
  │   └─vg_thin-thin_vol_client4        253:10   0    5G  0 lvm
  └─vg_thin-tp_cricbuzz_pool_tdata      253:4    0   15G  0 lvm
    └─vg_thin-tp_cricbuzz_pool-tpool    253:5    0   15G  0 lvm
      ├─vg_thin-tp_cricbuzz_pool        253:6    0   15G  1 lvm
      ├─vg_thin-thin_vol_client1        253:7    0    5G  0 lvm  /mnt/client1
      ├─vg_thin-thin_vol_client2        253:8    0    5G  0 lvm  /mnt/client2
      ├─vg_thin-thin_vol_client3        253:9    0    5G  0 lvm  /mnt/client3
      └─vg_thin-thin_vol_client4        253:10   0    5G  0 lvm
sr0                                      11:0    1 1024M  0 rom
```

24. Check the available volume group space as we want to extend pool size by 15GB, to avoid data loss-

```
[root@client1 client3]# vgs
  VG      #PV #LV #SN Attr   VSize   VFree
  rhel      1   3   0 wz--n- <59.00g     0
  vg_thin   1   4   0 wz--n- <19.97g <4.91g
[root@client1 client3]#
```

25. Currently we have 30GB space available in disk 'sdc'. We will use this complete space to create a new partition 'sdc2'-

```
[root@client1 client3]# fdisk /dev/sdc

Welcome to fdisk (util-linux 2.37.4).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

This disk is currently in use - repartitioning is probably a bad idea.
It's recommended to umount all file systems, and swapoff all swap
partitions on this disk.


Command (m for help): n
Partition type
   p   primary (1 primary, 0 extended, 3 free)
   e   extended (container for logical partitions)
Select (default p): p
Partition number (2-4, default 2): 2
First sector (41945088-104857599, default 41945088):
Last sector, +/-sectors or +/-size{K,M,G,T,P} (41945088-104857599, default 104857599):

Created a new partition 2 of type 'Linux' and of size 30 GiB.

Command (m for help): t
Partition number (1,2, default 2): 2
Hex code or alias (type L to list all): 8e

Changed type of partition 'Linux' to 'Linux LVM'.

Command (m for help): w
The partition table has been altered.
Syncing disks.

[root@client1 client3]# partprobe
[root@client1 client3]#
```

26. We can verify the same using lsblk-

```
[root@client1 client3]# lsblk
NAME                                  MAJ:MIN RM  SIZE RO TYPE MOUNTPOINTS
sda                                     8:0    0   10G  0 disk
sdb                                     8:16   0   10G  0 disk
├─sdb1                                  8:17   0    1G  0 part
├─sdb2                                  8:18   0    1G  0 part
└─sdb3                                  8:19   0    1G  0 part [SWAP]
sdc                                     8:32   0   50G  0 disk
├─sdc1                                  8:33   0   20G  0 part
│ ├─vg_thin-tp_cricbuzz_pool_tmeta    253:3    0   32M  0 lvm
│ │ └─vg_thin-tp_cricbuzz_pool-tpool  253:5    0   15G  0 lvm
│ │   ├─vg_thin-tp_cricbuzz_pool      253:6    0   15G  1 lvm
│ │   ├─vg_thin-thin_vol_client1      253:7    0    5G  0 lvm  /mnt/client1
│ │   ├─vg_thin-thin_vol_client2      253:8    0    5G  0 lvm  /mnt/client2
│ │   ├─vg_thin-thin_vol_client3      253:9    0    5G  0 lvm  /mnt/client3
│ │   └─vg_thin-thin_vol_client4      253:10   0    5G  0 lvm
│ └─vg_thin-tp_cricbuzz_pool_tdata    253:4    0   15G  0 lvm
│   └─vg_thin-tp_cricbuzz_pool-tpool  253:5    0   15G  0 lvm
│     ├─vg_thin-tp_cricbuzz_pool      253:6    0   15G  1 lvm
│     ├─vg_thin-thin_vol_client1      253:7    0    5G  0 lvm  /mnt/client1
│     ├─vg_thin-thin_vol_client2      253:8    0    5G  0 lvm  /mnt/client2
│     ├─vg_thin-thin_vol_client3      253:9    0    5G  0 lvm  /mnt/client3
│     └─vg_thin-thin_vol_client4      253:10   0    5G  0 lvm
└─sdc2                                  8:34   0   30G  0 part
```

27. Create new physical volume using this new partition & verify it-

```
[root@client1 client3]# pvcreate /dev/sdc2
  Physical volume "/dev/sdc2" successfully created.
[root@client1 client3]#
[root@client1 client3]#
[root@client1 client3]# pvs
  PV             VG      Fmt  Attr PSize   PFree
  /dev/nvme0n1p2 rhel    lvm2 a--  <59.00g      0
  /dev/sdc1      vg_thin lvm2 a--  <19.97g  <4.91g
  /dev/sdc2              lvm2 ---  <30.00g <30.00g
[root@client1 client3]#
```

28. Now, extend volume group by using this PV & verify-

```
[root@client1 client3]# vgextend vg_thin /dev/sdc2
  Volume group "vg_thin" successfully extended
[root@client1 client3]#
[root@client1 client3]#
[root@client1 client3]# vgs
  VG      #PV #LV #SN Attr   VSize   VFree
  rhel      1   3   0 wz--n- <59.00g      0
  vg_thin   2   5   0 wz--n- <49.94g <34.88g
[root@client1 client3]#
```

29. Extend the logical volume pool by 15GB-

```
[root@client1 client3]# lvextend -L +15G /dev/vg_thin/tp_cricbuzz_pool
  Size of logical volume vg_thin/tp_cricbuzz_pool_tdata changed from 15.00 GiB (480 extents) to 30.00 GiB (960 extents).
  Logical volume vg_thin/tp_cricbuzz_pool successfully resized.
[root@client1 client3]#
```

30. Verify volume group again after taking 15GB from it-

```
[root@client1 client3]# vgs
  VG      #PV #LV #SN Attr   VSize   VFree
  rhel      1   3   0 wz--n- <59.00g      0
  vg_thin   2   5   0 wz--n- <49.94g <19.88g
[root@client1 client3]#
```

31. At last, check the updated thin pool size & current utilization-

```
[root@client1 client3]# lvs
  LV              VG      Attr       LSize  Pool            Origin Data%  Meta%  Move Log Cpy%Sync Convert
  home            rhel    -wi-ao---- 18.69g
  root            rhel    -wi-ao---- 38.28g
  swap            rhel    -wi-ao----  2.02g
  thin_vol_client1 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        82.88
  thin_vol_client2 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        42.88
  thin_vol_client3 vg_thin Vwi-aotz--  5.00g tp_cricbuzz_pool        42.88
  thin_vol_client4 vg_thin Vwi-a-tz--  5.00g tp_cricbuzz_pool        0.00
  tp_cricbuzz_pool vg_thin twi-aotz-- 30.00g                        28.11  20.20
[root@client1 client3]#
```

This is it!!!