Linux 逻辑卷管理实验指导

0. 准备工作
   a) 在虚拟机中准备 Linux（Ubuntu，CentOS 等均可，以下以 Ubuntu 为例）
   b) 确认 lvm 相关命令已经安装。测试方法：sudo vgs，如果未安装 lvm，会有安装提示
1. 分配虚拟硬盘
   a) 为虚拟机分配二个新的虚拟硬盘，大小各为 20GB。
   b) 使用 sudo fdisk -l 确认，应该看到二个新的硬盘，假设虚拟机中原有一个硬盘 sda，新硬盘应该是 sdb 和 sdc。

```
ligang@ubuntu:~$ sudo fdisk -l
[sudo] password for ligang:
Disk /dev/sdb: 20 GiB, 21474836480 bytes, 41943040 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x8a6201ef


Disk /dev/sdc: 20 GiB, 21474836480 bytes, 41943040 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
```

2. 创建和扩大文件系统和相关逻辑卷管理
   a) 使用 fdisk 将 sdb 分出以下分区：
      i. sdb1：主分区，5G

```
ligang@ubuntu:~$ sudo fdisk /dev/sdb

Welcome to fdisk (util-linux 2.27.1).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.


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):
First sector (2048-41943039, default 2048):
Last sector, +sectors or +size{K,M,G,T,P} (2048-41943039, default 41943039): +5G

Created a new partition 1 of type 'Linux' and of size 5 GiB.
```

      ii. sdb2：扩展分区，15G

```
Command (m for help): n
Partition type
   p   primary (1 primary, 0 extended, 3 free)
   e   extended (container for logical partitions)
Select (default p): e
Partition number (2-4, default 2):
First sector (10487808-41943039, default 10487808):
Last sector, +sectors or +size{K,M,G,T,P} (10487808-41943039, default 41943039):

Created a new partition 2 of type 'Extended' and of size 15 GiB.
```

iii. sdb5、sdb6、sdb7：逻辑分区，各 5G

```
Command (m for help): n
All space for primary partitions is in use.
Adding logical partition 5
First sector (10489856-41943039, default 10489856):
Last sector, +sectors or +size{K,M,G,T,P} (10489856-41943039, default 41943039): +5G

Created a new partition 5 of type 'Linux' and of size 5 GiB.

Command (m for help): n
All space for primary partitions is in use.
Adding logical partition 6
First sector (20977664-41943039, default 20977664):
Last sector, +sectors or +size{K,M,G,T,P} (20977664-41943039, default 41943039): +5G

Created a new partition 6 of type 'Linux' and of size 5 GiB.

Command (m for help): n
All space for primary partitions is in use.
Adding logical partition 7
First sector (31465472-41943039, default 31465472):
Last sector, +sectors or +size{K,M,G,T,P} (31465472-41943039, default 41943039):

Created a new partition 7 of type 'Linux' and of size 5 GiB.
```

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

b) 将 sdb6 和 sdc 初始化为物理卷（PV）

```
ligang@ubuntu:~$ sudo pvcreate /dev/sdb6
  Physical volume "/dev/sdb6" successfully created
ligang@ubuntu:~$ sudo pvcreate /dev/sdc
  Physical volume "/dev/sdc" successfully created
ligang@ubuntu:~$ sudo pvs
  PV         VG   Fmt  Attr PSize  PFree
  /dev/sdb6       lvm2 ---   5.00g  5.00g
  /dev/sdc        lvm2 ---  20.00g 20.00g
```

c) 将 sdb6 和 sdc 加入卷组（VG）vg00 中

```
ligang@ubuntu:~$ sudo vgcreate vg00 /dev/sdb6
  Volume group "vg00" successfully created
ligang@ubuntu:~$ sudo vgextend vg00 /dev/sdc
  Volume group "vg00" successfully extended
ligang@ubuntu:~$ sudo vgs
  VG   #PV #LV #SN Attr   VSize  VFree
  vg00   2   0   0 wz--n- 24.99g 24.99g
```

d) 在 vg00 中创建逻辑卷（LV）lv00，初始大小为 10G

```
ligang@ubuntu:~$ sudo lvcreate -L 10G -n lv00 /dev/vg00
  Logical volume "lv00" created.
ligang@ubuntu:~$ sudo lvs
  LV   VG   Attr       LSize  Pool Origin Data%  Meta%  Move Log Cpy%Sync Convert
  lv00 vg00 -wi-a----- 10.00g
```

e) 在 lv00 中创建文件系统并装载

```
ligang@ubuntu:~$ sudo mkfs.ext4 /dev/vg00/lv00
mke2fs 1.42.13 (17-May-2015)
Creating filesystem with 2621440 4k blocks and 655360 inodes
Filesystem UUID: e7bac38f-f221-46ee-b538-79fcffc68a73
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632

Allocating group tables: done
Writing inode tables: done
Creating journal (32768 blocks): done
Writing superblocks and filesystem accounting information: done

ligang@ubuntu:~$ sudo mkdir /data
ligang@ubuntu:~$ sudo mount /dev/vg00/lv00 /data
```

f) 在新文件系统中创建一个 8G 的大文件 bigfile1

```
ligang@ubuntu:/data$ sudo dd if=/dev/zero of=/data/bigfile1 bs=1M count=8192
8192+0 records in
8192+0 records out
8589934592 bytes (8.6 GB, 8.0 GiB) copied, 8.24174 s, 1.0 GB/s
ligang@ubuntu:/data$ ls -lh
total 8.1G
-rw-r--r-- 1 root root 8.0G Sep 28 15:17 bigfile1
drwx------ 2 root root  16K Sep 28 15:09 lost+found
ligang@ubuntu:/data$ df -h
Filesystem             Size  Used Avail Use% Mounted on
udev                   455M     0  455M   0% /dev
tmpfs                   97M   12M   86M  12% /run
/dev/sda1               19G  6.0G   12G  34% /
tmpfs                  482M  224K  482M   1% /dev/shm
tmpfs                  5.0M  4.0K  5.0M   1% /run/lock
tmpfs                  482M     0  482M   0% /sys/fs/cgroup
tmpfs                   97M   72K   97M   1% /run/user/1000
/dev/mapper/vg00-lv00  9.8G  8.1G  1.2G  88% /data
```

g) 这时假设又要一个大文件 bigfile2，大小为 10GB。文件系统已经不够大了，需要扩大 lv 和 fs。

```
ligang@ubuntu:/data$ sudo lvextend -L 20G /dev/vg00/lv00
  Size of logical volume vg00/lv00 changed from 10.00 GiB (2560 extents) to 20.00 GiB
 (5120 extents).
  Logical volume lv00 successfully resized.
ligang@ubuntu:/data$ sudo resize2fs /dev/vg00/lv00
resize2fs 1.42.13 (17-May-2015)
Filesystem at /dev/vg00/lv00 is mounted on /data; on-line resizing required
old_desc_blocks = 1, new_desc_blocks = 2
The filesystem on /dev/vg00/lv00 is now 5242880 (4k) blocks long.

ligang@ubuntu:/data$ df -h
Filesystem             Size  Used Avail Use% Mounted on
udev                   455M     0  455M   0% /dev
tmpfs                   97M   12M   86M  12% /run
/dev/sda1               19G  6.0G   12G  34% /
tmpfs                  482M  224K  482M   1% /dev/shm
tmpfs                  5.0M  4.0K  5.0M   1% /run/lock
tmpfs                  482M     0  482M   0% /sys/fs/cgroup
tmpfs                   97M   72K   97M   1% /run/user/1000
/dev/mapper/vg00-lv00_  20G  8.1G   11G  44% /data

ligang@ubuntu:/data$ sudo dd if=/dev/zero of=/data/bigfile2 bs=1M count=10240
10240+0 records in
10240+0 records out
10737418240 bytes (11 GB, 10 GiB) copied, 10.2673 s, 1.0 GB/s
ligang@ubuntu:/data$ ls -lh
total 19G
-rw-r--r-- 1 root root 8.0G Sep 28 15:17 bigfile1
-rw-r--r-- 1 root root  10G Sep 28 15:39 bigfile2
drwx------ 2 root root  16K Sep 28 15:09 lost+found
```

h) 这时候又要再放一个大文件 bigfile3，大小为 9GB。这样，pv 中剩余空间也不够了，需要先扩 pv，再扩 lv 和 fs。

```
ligang@ubuntu:/data$ sudo pvcreate /dev/sdb5
  Physical volume "/dev/sdb5" successfully created

ligang@ubuntu:/data$ sudo vgextend vg00 /dev/sdb5
  Volume group "vg00" successfully extended

ligang@ubuntu:/data$ sudo vgs
  VG   #PV #LV #SN Attr   VSize  VFree
  vg00   3   1   0 wz--n- 29.99g 4.99g
ligang@ubuntu:/data$ sudo lvextend -L 29G /dev/vg00/lv00
  Size of logical volume vg00/lv00 changed from 25.00 GiB (6400 extents) to 29.00 GiB
 (7424 extents).
  Logical volume lv00 successfully resized.
ligang@ubuntu:/data$ sudo resize2fs /dev/vg00/lv00
resize2fs 1.42.13 (17-May-2015)
Filesystem at /dev/vg00/lv00 is mounted on /data; on-line resizing required
old_desc_blocks = 2, new_desc_blocks = 2
The filesystem on /dev/vg00/lv00 is now 7602176 (4k) blocks long.

ligang@ubuntu:/data$ df -h
Filesystem             Size  Used Avail Use% Mounted on
udev                   455M     0  455M   0% /dev
tmpfs                   97M   12M   86M  12% /run
/dev/sda1               19G  6.0G   12G  34% /
tmpfs                  482M  224K  482M   1% /dev/shm
tmpfs                  5.0M  4.0K  5.0M   1% /run/lock
tmpfs                  482M     0  482M   0% /sys/fs/cgroup
tmpfs                   97M   72K   97M   1% /run/user/1000
/dev/mapper/vg00-lv00_  29G   19G  9.2G  67% /data
```

```
ligang@ubuntu:/data$ sudo dd if=/dev/zero of=/data/bigfile3 bs=1M count=9216
9216+0 records in
9216+0 records out
9663676416 bytes (9.7 GB, 9.0 GiB) copied, 8.45497 s, 1.1 GB/s
ligang@ubuntu:/data$ ls -lh
total 28G
-rw-r--r-- 1 root root 8.0G Sep 28 15:17 bigfile1
-rw-r--r-- 1 root root  10G Sep 28 15:39 bigfile2
-rw-r--r-- 1 root root 9.0G Sep 28 15:45 bigfile3
drwx------ 2 root root  16K Sep 28 15:09 lost+found
ligang@ubuntu:/data$ df -h /data
Filesystem             Size  Used Avail Use% Mounted on
/dev/mapper/vg00-lv00   29G   28G  127M 100% /data
```

i) 小结，我们使用由 sdb5（5GB）、sdb6（5GB）、sdc（20GB）组成的卷组 vg00，大小为 30GB，在其中创建一个大小为 29GB 的逻辑卷 lv00，此逻辑卷中创建了大小为 29GB 的文件系统，并存放了 bigfile1（8G）、bigfile2（10G）、bigfile3（9G）共 27GB 的数据。文件系统可以随时扩大。

3. 缩小文件系统和相关的逻辑卷管理

a) 删除 bigfile2，umount 文件系统，为缩小文件系统做准备

```
ligang@ubuntu:/data$ sudo rm bigfile2
ligang@ubuntu:/data$ cd
ligang@ubuntu:~$ sudo umount /data
```

```
ligang@ubuntu:~$ sudo e2fsck -f /dev/vg00/lv00
e2fsck 1.42.13 (17-May-2015)
Pass 1: Checking inodes, blocks, and sizes
Pass 2: Checking directory structure
Pass 3: Checking directory connectivity
Pass 4: Checking reference counts
Pass 5: Checking group summary information
/dev/vg00/lv00: 13/1900544 files (0.0% non-contiguous), 4615523/7602176 blocks
```

b) 缩小文件系统、缩小逻辑卷（注意顺序）

```
ligang@ubuntu:~$ sudo resize2fs /dev/vg00/lv00 20G
resize2fs 1.42.13 (17-May-2015)
Resizing the filesystem on /dev/vg00/lv00 to 5242880 (4k) blocks.
The filesystem on /dev/vg00/lv00 is now 5242880 (4k) blocks long.
```

```
ligang@ubuntu:~$ sudo lvreduce -L 21G /dev/vg00/lv00
  WARNING: Reducing active logical volume to 21.00 GiB
  THIS MAY DESTROY YOUR DATA (filesystem etc.)
Do you really want to reduce lv00? [y/n]: y
  Size of logical volume vg00/lv00 changed from 29.00 GiB (7424 extents) to 21.00 GiB
 (5376 extents).
  Logical volume lv00 successfully resized.

ligang@ubuntu:~$ sudo mount /dev/vg00/lv00 /data
ligang@ubuntu:~$ df -h /data
Filesystem             Size  Used Avail Use% Mounted on
/dev/mapper/vg00-lv00   20G   18G  1.7G  92% /data
```