

Network Administration/System Administration (NTU CSIE, Spring 2024)

Homework #3

B12902110 呂承諺

1 Initial partition

Steps

1. Run `fdisk /dev/vda`.
2. Run the following commands inside `fdisk`:

```
Command (m for help): g
Created a new GPT disklabel (GUID: C55CEE8B-500E-4F53-BD71-CD40DA22FBE1).
```

```
Command (m for help): n
Partition number (1-128, default 1):
First sector (2048-2097118, default 2048):
Last sector, +/-sectors or +/-size{K,M,G,T,P} (2048-2097118, default 2095103): +1M
```

```
Created a new partition 1 of type 'Linux filesystem' and of size 1 MiB.
```

```
Command (m for help): t
Selected partition 1
Partition type or alias (type L to list all): 4
Changed type of partition 'Linux filesystem' to 'BIOS boot'.
```

```
Command (m for help): n
Partition number (2-128, default 2):
First sector (4096-2097118, default 4096):
Last sector, +/-sectors or +/-size{K,M,G,T,P} (4096-2097118, default 2095103): +100M
```

```
Created a new partition 2 of type 'Linux filesystem' and of size 100 MiB.
```

```
Command (m for help): n
Partition number (3-128, default 3):
First sector (208896-2097118, default 208896):
Last sector, +/-sectors or +/-size{K,M,G,T,P} (208896-2097118, default 2095103):
```

```
Created a new partition 3 of type 'Linux filesystem' and of size 921 MiB.
```

```
Command (m for help): t
Partition number (1-3, default 3): 3
Partition type or alias (type L to list all): 44
```

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

```
Command (m for help): w
```

Result Below is the output of `fdisk -l /dev/vda`:

```
Disk /dev/vda: 1 GiB, 1073741824 bytes, 2097152 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: gpt
Disk identifier: C4F827B5-EBD3-4195-9A91-603764104ABE

Device        Start      End Sectors  Size Type
/dev/vda1     2048      4095    2048    1M BIOS boot
/dev/vda2     4096    413695  409600  200M Linux filesystem
/dev/vda3    413696  2095103 1681408  821M Linux LVM
```

References

- `fdisk` partition types

2 RAID Setup

Steps Run the following commands:

```
mdadm --create /dev/md127 --level 10 --name data --raid-devices 4 \
    /dev/vdc /dev/vdd /dev/vde /dev/vdf
mdadm --create /dev/md126 --level 0 --name linux --raid-devices 2 \
    /dev/vda3 /dev/vdb
```

Result Below is the output of `cat /proc/mdstat`:

```
root@archiso ~ #
root@archiso ~ # cat /proc/mdstat
Personalities : [raid10] [raid0]
md126 : active raid0 vdb[1] vda3[0]
        1885184 blocks super 1.2 512k chunks

md127 : active raid10 vdf[3] vde[2] vdd[1] vdc[0]
        2093056 blocks super 1.2 512K chunks 2 near-copies [4/4] [UUUU]

unused devices: <none>
root@archiso ~ #
```

References

- `mdadm --create --help`

3 Disk encryption

Steps

1. Encrypt `/dev/vda2` and map it to `/dev/mapper/cryptboot`:

```
cryptsetup luksFormat --type luks1 /dev/vda2
cryptsetup open /dev/vda2 cryptboot
```

2. Generate a random 256-bit key, and add it as a key of `/dev/mapper/cryptboot`:

```
dd if=/dev/random of=b12902110.key bs=256 count=1|
cryptsetup luksAddKey /dev/vda2 /root/password
```

3. Encrypt /dev/md/linux and map it to /dev/mapper/cryptroot:

```
cryptsetup luksFormat --type luks2 /dev/md/linux b12902110.key
cryptsetup open /dev/md/linux cryptroot
```

4. Encrypt /dev/md/data and map it to /dev/mapper/cryptdata:

```
cryptsetup luksFormat --type luks2 /dev/md/data b12902110.key
cryptsetup open /dev/md/data cryptdata
```

Result Below is the output of `lsblk -f` and `cryptsetup status`:

```
root@archiso ~ # lsblk -f
NAME        FSTYPE      FSVER      LABEL          UUID                                 FSAVAIL FSUSE% MOUNTPOINTS
fd0
loop0       squashfs    4.0
sr0         iso9660     Joliet Extension ARCH_202312   2023-12-01-15-40-55-00           0    100% /run/archiso/airootfs
sr1
vda
├─vda1
├─vda2      crypto_LUKS    1                                b0ae0010-2ed6-4fed-801c-d8ae94e85fb1
│   └─cryptboot
├─vda3      linux_raid_member 1.2                    archiso:linux 420c7ac3-a171-18da-827f-4fd9399d3f75
│   └─md126  crypto_LUKS    2                                8b0a0d4e-f544-4e58-84ba-1e3ace621bf4
│       └─cryptroot
├─vdb       linux_raid_member 1.2                    archiso:linux 420c7ac3-a171-18da-827f-4fd9399d3f75
│   └─md126  crypto_LUKS    2                                8b0a0d4e-f544-4e58-84ba-1e3ace621bf4
│       └─cryptroot
├─vdc       linux_raid_member 1.2                    archiso:data  9b03ce55-43c3-0cca-2768-db6c2ea79769
│   └─md127  crypto_LUKS    2                                7a983ed6-5c94-4207-bc9e-7e59eda6bd06
│       └─cryptdata
├─vdd       linux_raid_member 1.2                    archiso:data  9b03ce55-43c3-0cca-2768-db6c2ea79769
│   └─md127  crypto_LUKS    2                                7a983ed6-5c94-4207-bc9e-7e59eda6bd06
│       └─cryptdata
├─vde       linux_raid_member 1.2                    archiso:data  9b03ce55-43c3-0cca-2768-db6c2ea79769
│   └─md127  crypto_LUKS    2                                7a983ed6-5c94-4207-bc9e-7e59eda6bd06
│       └─cryptdata
└─vdf       linux_raid_member 1.2                    archiso:data  9b03ce55-43c3-0cca-2768-db6c2ea79769
    └─md127  crypto_LUKS    2                                7a983ed6-5c94-4207-bc9e-7e59eda6bd06
        └─cryptdata
root@archiso ~ #
```

```
root@archiso ~ # cryptsetup status /dev/mapper/cryptboot
/dev/mapper/cryptboot is active.
  type:          LUKS1
  cipher:        aes-xts-plain64
  keysizes:      512 bits
  key location:  dm-crypt
  device:        /dev/vda2
  sector size:   512
  offset:        4096 sectors
  size:          405504 sectors
  mode:          read/write
root@archiso ~ # cryptsetup status /dev/mapper/cryptroot
/dev/mapper/cryptroot is active.
  type:          LUKS2
  cipher:        aes-xts-plain64
  keysizes:      512 bits
  key location:  keyring
  device:        /dev/md126
  sector size:   512
  offset:        32768 sectors
  size:          3737600 sectors
  mode:          read/write
root@archiso ~ # cryptsetup status /dev/mapper/cryptdata
/dev/mapper/cryptdata is active.
  type:          LUKS2
  cipher:        aes-xts-plain64
  keysizes:      512 bits
  key location:  keyring
  device:        /dev/md127
  sector size:   512
  offset:        32768 sectors
  size:          4153344 sectors
  mode:          read/write
root@archiso ~ #
```

References

- [dm-crypt/Device encryption - ArchWiki](#)
- [Linux Unified Key Setup - Wikipedia](#)
- `man dd`
- [mdadm raid doesn't mount - Unix & Linux Stack Exchange](#)
- [How to determine what encryption is being used a LUKS partition? - Unix & Linux Stack Exchange](#)
- `man lsblk`

4 LVM Setup

Steps Run the following commands:

```
pvcreate /dev/mapper/cryptroot
vgcreate linux /dev/mapper/cryptroot
lvcreate --size 256M --name home linux
lvcreate --extents 100%FREE --name root linux cryptdata
```

Result Below is the output of `pvs`, `vgs`, `lvs`, and `fdisk -l`:

```
root@archiso ~ # pvs
PV                VG      Fmt Attr PSize PFree
/dev/mapper/cryptroot linux  lvm2 a-- 1.78g 0
root@archiso ~ # vgs
VG      #PV #LV #SN Attr   VSize VFree
linux   1   2   0 wz--n- 1.78g 0
root@archiso ~ # lvs
LV      VG      Attr   LSize   Pool Origin Data%  Meta%   Move Log Cpy%Sync Convert
home    linux -wi-a----- 256.00m
root    linux -wi-a----- 1.53g
root@archiso ~ # lsblk -f
NAME                FSTYPE              FSUVER          LABEL        UUID                                  FSAVAIL FSUSE% MOUNTPOINTS
fd0                  squashfs             4.0
sr0                  iso9660              Joliet Extension ARCH_202312   2023-12-01-15-40-55-00
sr1
vda
├─vda1
├─vda2
├─vda3
│   └─md126
│       └─cryptroot
│           └─linux-home
│               └─linux-root
vdb
├─md126
│   └─cryptroot
│       └─linux-home
│           └─linux-root
vdc
├─md127
│   └─cryptdata
vdd
├─md127
│   └─cryptdata
vde
├─md127
│   └─cryptdata
vdf
├─md127
│   └─cryptdata
```

References

- `man pvcreate`, `man vgcreate` and `man lvcreate`
- [Section “LVM usage” of “Partition lab 2024 - HackMD”](#)

5 Formatting

Steps Run the following commands:

```
mkfs.ext4 /dev/linux/home
mkfs.ext4 /dev/linux/root
mkfs.xfs /dev/mapper/cryptdata
mkfs.ext2 /dev/mapper/cryptboot
```

Result Below is the output of `fdisk -l` after formatting:

```
root@archiso ~ # lsblk -f
NAME                                FSTYPE      FSVER      LABEL      UUID                                  FSAVAIL FSUSE% MOUNTPOINTS
fd0                                  squashfs     4.0        Joliet Extension ARCH_202312    2023-12-01-15-40-55-00      0      100% /run/archiso/airootfs
sr0                                  iso9660      Joliet Extension ARCH_202312    2023-12-01-15-40-55-00      0      100% /run/archiso/bootmnt

vda
├─vda1
├─vda2
│   └─cryptboot
│       └─vda3
│           └─md126
│               └─cryptroot
│                   └─linux-home ext4
│                       └─linux-root ext4
├─vda3
│   └─md126
│       └─cryptroot
│           └─linux-home ext4
│               └─linux-root ext4
├─vda4
│   └─md127
│       └─cryptdata
├─vda5
│   └─md127
│       └─cryptdata
├─vda6
│   └─md127
│       └─cryptdata
├─vda7
│   └─md127
│       └─cryptdata
└─vda8
    └─md127
        └─cryptdata
```

6 Mounting

Steps Run the following commands:

```
mount /dev/linux/root /mnt
mount /dev/linux/home /mnt/home --mkdir
mount /dev/mapper/cryptboot /mnt/boot --mkdir
mount /dev/mapper/cryptdata /mnt/data --mkdir
```

Result Below is the output of `mount` and `ls -alh /mnt`:

```

root@archiso /mnt # mount
proc on /proc type proc (rw,nosuid,nodev,noexec,relatime)
sys on /sys type sysfs (rw,nosuid,nodev,noexec,relatime)
dev on /dev type devtmpfs (rw,nosuid,relatime,size=1962252k,nr_inodes=490563,mode=755,inode64)
run on /run type tmpfs (rw,nosuid,nodev,relatime,mode=755,inode64)
/dev/sr0 on /run/archiso/bootmnt type iso9660 (ro,relatime,nojoliet,check=s,map=n,blocksize=2048,iocharset=utf8)
cowspace on /run/archiso/cowspace type tmpfs (rw,relatime,size=262144k,mode=755,inode64)
/dev/loop0 on /run/archiso/airootfs type squashfs (ro,relatime,errors=continue,threads=single)
airootfs on / type overlay (rw,relatime,lowerdir=/run/archiso/airootfs,upperdir=/run/archiso/cowspace/persistent/_x86_64/upperdir,workdir=/run/archiso/cowspace/persistent/_x86_64/workdir,uuid=on)
securityfs on /sys/kernel/security type securityfs (rw,nosuid,nodev,noexec,relatime)
tmpfs on /dev/shm type tmpfs (rw,nosuid,nodev,inode64)
devpts on /dev/pts type devpts (rw,nosuid,noexec,relatime,gid=5,mode=620,ptmxmode=000)
cgroup2 on /sys/fs/cgroup type cgroup2 (rw,nosuid,nodev,noexec,relatime,nsdelegate,memory_recursiveprot)
pstore on /sys/fs/pstore type pstore (rw,nosuid,nodev,noexec,relatime)
bpf on /sys/fs/bpf type bpf (rw,nosuid,nodev,noexec,relatime,mode=700)
systemd-1 on /proc/sys/fs/binfmt_misc type autofs (rw,relatime,fd=35,pgrp=1,timeout=0,minproto=5,maxproto=5,direct,pipe_ino=1639)
hugetlbfs on /dev/hugepages type hugetlbfs (rw,nosuid,nodev,relatime,pagesize=2M)
tmpfs on /tmp type tmpfs (rw,nosuid,nodev,size=2006520k,nr_inodes=1048576,inode64)
tracefs on /sys/kernel/tracing type tracefs (rw,nosuid,nodev,noexec,relatime)
debugfs on /sys/kernel/debug type debugfs (rw,nosuid,nodev,noexec,relatime)
mqueue on /dev/mqueue type mqueue (rw,nosuid,nodev,noexec,relatime)
configfs on /sys/kernel/config type configfs (rw,nosuid,nodev,noexec,relatime)
fusectl on /sys/fs/fuse/connections type fusectl (rw,nosuid,nodev,noexec,relatime)
tmpfs on /etc/pacman.d/gnupg type tmpfs (rw,relatime,mode=755,inode64,noswap)
tmpfs on /run/user/0 type tmpfs (rw,nosuid,nodev,relatime,size=401300k,nr_inodes=100325,mode=700,inode64)
/dev/mapper/linux-root on /mnt type ext4 (rw,relatime,stripe=256)
/dev/mapper/linux-home on /mnt/home type ext4 (rw,relatime,stripe=1024)
/dev/mapper/cryptboot on /mnt/boot type ext2 (rw,relatime)
/dev/mapper/cryptdata on /mnt/data type xfs (rw,relatime,attr2,inode64,logbufs=8,logbsize=32k,sunit=1024,swidth=2048,noquota)
root@archiso /mnt # ls -alh /mnt
total 22K
drwxr-xr-x 6 root root 4.0K Mar  8 17:59 .
drwxr-xr-x 1 root root 100 Mar  8 16:27 ..
drwxr-xr-x 3 root root 1.0K Mar  8 17:56 boot
drwxr-xr-x 2 root root  6 Mar  8 17:55 data
drwxr-xr-x 3 root root 1.0K Mar  8 17:53 home
drwx----- 2 root root 16K Mar  8 17:53 lost+found
root@archiso /mnt #

```

7 Arch Installation

Steps

- Run `pacman -Sy --needed archlinux-keyring` to update archlinux-keyring to the latest version 20240208-1. Otherwise we would get “signature is unknown trust” errors.
- Follow [ArchWiki’s installation guide](#) and run the following commands:

```
pacstrap -K /mnt base linux
```

```
genfstab -U /mnt >> /mnt/etc/fstab
```

```
arch-chroot /mnt
```

```
pacman -Syu
```

```
pacman -S mdadm lvm2 nano man
```

```
ln -s /usr/share/zoneinfo/Asia/Taipei /etc/localtime
```

```
hwclock --systohc
```

```
# Edit /etc/locale.gen and uncomment en_US.UTF-8.
```

```
locale-gen
```

```
echo "LANG=en_US.UTF-8" > /etc/locale.conf
```

```
# Edit /etc/hostname and change hostname to new-arch-b12902110.
```

```
passwd
```

- Move key generated by step 3 to `/etc/cryptsetup-keys.d`.
- Edit `/etc/mkinitcpio.conf` and add `encrypt`, `lvm2`, `mdadm_udev` to `HOOKS`. Also add `/etc/cryptsetup-keys.d/b12902110.key` to `FILES`.

- Run `mkinitcpio -p linux`.
- Add the following lines to `/etc/crypttab`:


```
# UUID of /dev/vda2
cryptboot UUID=b0ae0010-2ed6-4fed-801c-d8ae94e85fb1 /etc/cryptsetup-keys.d/b12902110.key
# UUID of /dev/md/data
cryptdata UUID=7a983ed6-5c94-4207-bc9e-7e59eda6bd06 /etc/cryptsetup-keys.d/b12902110.key
```
- Run `pacman -S grub` to Install GRUB.
- Edit the following lines in `/etc/default/grub`:


```
GRUB_CMDLINE_LINUX="root=/dev/linux/root \
cryptdevice=UUID=8b0a0d4e-f544-4e58-84ba-1e3ace621bf4:cryptroot \
cryptkey=rootfs:/etc/cryptsetup-keys.d/b12902110.key"

GRUB_ENABLE_CRYPTODISK=y
```
- Run the following commands:


```
grub-install /dev/vda
grub-mkconfig -o /boot/grub/grub.cfg
```

Result After rebooting and logging in, we see that all volumes have been correctly mounted.

```
Arch Linux 6.7.9-arch1-1 (tty1)
new-arch-of-b12902110 login: root
Password:
Last login: Sun Mar 10 15:37:17 on tty1
[root@new-arch-of-b12902110 ~]# lsblk -f
```

NAME	FSTYPE	FSVER	LABEL	UUID	FSAVAIL	FSUSE%	MOUNTPOINTS
fd0							
sr0	iso9660		Joliet Extension ARCH_202312	2023-12-01-15-40-55-00			
sr1							
vda							
└─vda1							
└─vda2	crypto_LUKS	1		b0ae0010-2ed6-4fed-801c-d8ae94e85fb1			
└─┬─cryptboot	ext2	1.0		b1eb3009-5dee-47cb-9e67-e06606d61a8f	79.2M	52%	/boot
└─vda3	linux_raid_member	1.2	archiso:linux	420c7ac3-a171-18da-827f-4fd9399d3f75			
└─┬─md126	crypto_LUKS	2		8b0a0d4e-f544-4e58-84ba-1e3ace621bf4			
└─┬─┬─cryptroot	LVM2_member	LVM2 001		tex4m9-luEU-0seo-X0ux-2ppw-raC4-eNjJzd			
└─└─┬─linux-home	ext4	1.0		e8e68614-e423-494f-bc5e-c8baf85b9643	213M	0%	/home
└─└─┬─linux-root	ext4	1.0		537c398f-b651-4226-8069-b726cc9af677	138.1M	85%	/
└─└─└─linux-raid_member	linux_raid_member	1.2	archiso:linux	420c7ac3-a171-18da-827f-4fd9399d3f75			
└─┬─md126	crypto_LUKS	2		8b0a0d4e-f544-4e58-84ba-1e3ace621bf4			
└─┬─┬─cryptroot	LVM2_member	LVM2 001		tex4m9-luEU-0seo-X0ux-2ppw-raC4-eNjJzd			
└─└─┬─linux-home	ext4	1.0		e8e68614-e423-494f-bc5e-c8baf85b9643	213M	0%	/home
└─└─┬─linux-root	ext4	1.0		537c398f-b651-4226-8069-b726cc9af677	138.1M	85%	/
└─└─└─linux_raid_member	linux_raid_member	1.2	archiso:data	9b03ce55-43c3-0cca-2768-d66c2ea79769			
└─┬─md127	crypto_LUKS	2		7a983ed6-5c94-4207-bc9e-7e59eda6bd06			
└─┬─┬─cryptdata	xfs			565fd777-8809-44b6-a096-021eea456818	1.8G	4%	/data
└─└─┬─md127	crypto_LUKS	2		7a983ed6-5c94-4207-bc9e-7e59eda6bd06			
└─└─┬─┬─cryptdata	xfs			565fd777-8809-44b6-a096-021eea456818	1.8G	4%	/data
└─└─└─linux_raid_member	linux_raid_member	1.2	archiso:data	9b03ce55-43c3-0cca-2768-d66c2ea79769			
└─┬─md127	crypto_LUKS	2		7a983ed6-5c94-4207-bc9e-7e59eda6bd06			
└─┬─┬─cryptdata	xfs			565fd777-8809-44b6-a096-021eea456818	1.8G	4%	/data
└─└─┬─md127	crypto_LUKS	2		7a983ed6-5c94-4207-bc9e-7e59eda6bd06			
└─└─┬─┬─cryptdata	xfs			565fd777-8809-44b6-a096-021eea456818	1.8G	4%	/data

```
[root@new-arch-of-b12902110 ~]#
```

References

- [Installation guide - ArchWiki \(Installation\)](#)
- [pacstrap\(8\) —Arch manual pages](#)
- `man genfstab`, `man arch-chroot`, `man hwclock`
- [chroot - ArchWiki](#)

- [locale.conf\(5\)](#) —Arch manual pages

Fixing package signature issue:

- [\[Resolved\] Can't import and use PGP keys / Pacman & Package Upgrade Issues / Arch Linux Forums](#)
- [pacman/Package signing - ArchWiki \(Signature is unknown trust\)](#)

mkinitcpio:

- [mkinitcpio - ArchWiki](#)
- [Ramfs, rootfs and initramfs —The Linux Kernel documentation](#)
- [RAID - ArchWiki \(Configure mkinitcpio \)](#)

Encryption:

- [dm-crypt/System configuration - ArchWiki \(Unlocking in late userspace\)](#)
- [crypttab\(5\)](#) —Arch manual pages
- [dm-crypt/System configuration - ArchWiki \(mkinitcpio\)](#)
- [Kernel parameters - ArchWiki](#)
- [Arch boot process - ArchWiki](#)
- [GRUB - ArchWiki \(Encrypted /boot\)](#)
- [dm-crypt/Device encryption - ArchWiki \(With a keyfile embedded in the initramfs \)](#)
- [dm-crypt/Encrypting an entire system - ArchWiki \(Encrypted boot partition \(GRUB\)\)](#)

GRUB and booting:

- [Master boot record - Wikipedia](#)
- [Boot sector - Wikipedia](#)
- [GNU GRUB - Wikipedia](#)
- [GNU GRUB Manual 2.12: BIOS installation](#)
- [GNU GRUB Manual 2.12: Simple configuration](#)
- [grub-install\(8\)](#) —Arch manual pages

Others:

- [Install Arch Linux on LVM - ArchWiki](#)
- [\[SOLVED\] LVM on LUKS Installation - emergency shell on boot / Installation / Arch Linux Forums](#)
- [Mount LVM Partition in Rescue Mode - ShellHacks](#)

8 Trivia

- (a) The partition table. That is Master Boot Record (MBR) or GUID Partition Table (GPT).
- (b) By default, 5% of the filesystem blocks will be reserved for the super-user. We can see this by running `tune2fs -l DEVICE | grep Reserved`.

References:

- [disk usage - df -h - Used space + Avail Free space is less than the Total size of /home - Ask Ubuntu](#)
 - [Ext4 - ArchWiki \(Reserved blocks\)](#)
- (c)
- **FUSE:** A software interface that allows non-privileged users to create their own file systems without needing to modify the kernel code directly. The developer uses the `libfuse` library to write a handler program that handle file I/Os.
 - **Advantages:** Can be written in any popular programming language. Easier to debug.
 - **Disadvantage:** May be slower.
 - **Examples:** GlusterFS, GmailFS.

References:

- [Filesystem in Userspace - Wikipedia](#)
 - [What is the advantage of FUSE \(file system in user space\)? - Quora](#)
 - [linux - What makes a fuse file system different than a kernel file system? - Super User](#)
- (d) MBR vs. GPT:

	MBR	GPT
Meaning	Master Boot Record	GUID Partition Table
Maximum partitions	4 primary, or 3 primary and 1 extended	128
Maximum disk sectors	2^{32} sectors	2^{64} sectors

References:

- [Master boot record - Wikipedia](#)
 - [GUID Partition Table - Wikipedia](#)
 - [UEFI/GPT-based hard drive partitions | Microsoft Learn](#)
- (e) `mount -t ntfs3 DEVICE MOUNTPOINT`

References:

- [Comparison of file systems - Wikipedia](#)
- [exFAT - Wikipedia](#)
- [NTFS - Wikipedia](#)
- [NTFS - ArchWiki](#)
- [NTFS3 —The Linux Kernel documentation](#)

- (f) 1 GB (gigabyte) = 10^9 bytes. 1 GiB (gibibyte) = 1024^3 bytes = 1073741824 bytes. `ls -h` uses powers of 1024 by default.

References:

- [Gigabyte - Wikipedia](#)
- `man ls`

- (g) Assuming 4 disks. 1st is fastest, 4th is slowest.

	Redundancy (Max. disks that we can lose)	Read speed	Write speed
RAID 0	0	1st	1st
RAID 10	2 (only if 1 in every RAID 1)	2nd	4th
RAID 5	1	3rd	2st
RAID 6	2	3rd	3rd

References:

- [Standard RAID levels - Wikipedia](#)
- [Nested RAID levels - Wikipedia](#)

- (h) Maybe because encryption overhead is the bottleneck, that is, the slowest process of all processes.