102: Linux

May, 2023

Audience

- Those who have some basic knowledge of how an OS works

Materials

- Filesystems overview
- Linux filesystem
- Bash command review
- Shell script flow control
- Networking

US patent

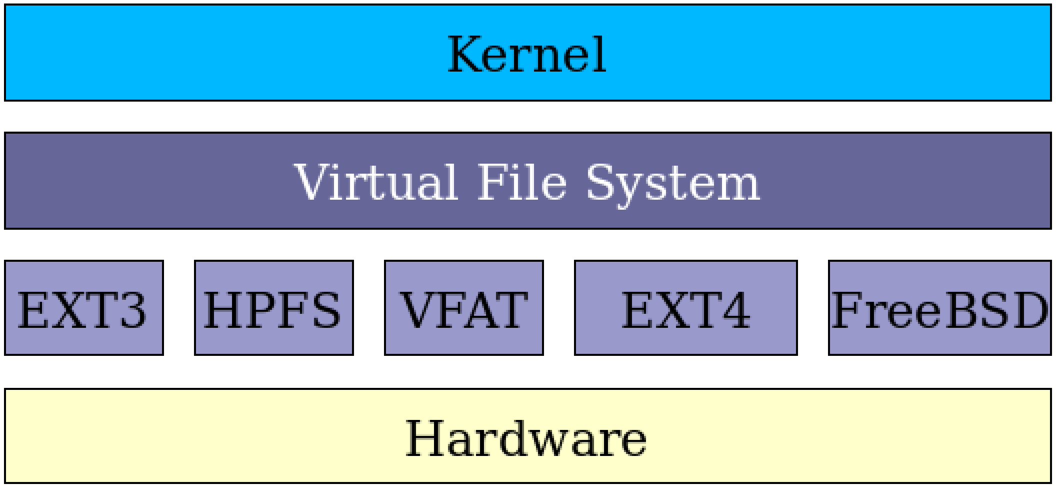
File Allocation Table (FAT) (1977~)

- FAT12 (1982, MS-DOS 1.25)
  - Volume max 32MB
  - Max no. of files: 4068
- FAT16 (1988, MS-DOS 4.0)
  - Volume max 2GB*
  - Max no. of files: 65460
- FAT32 (1996, Windows 95 OSR2)
  - Max file size: 4GB
  - Volume max 16TB*
- exFAT (2006)
  - Max file size: 16EB*
  - Volume max 128PB
- 8.3 filename and LFN
  - FILENA~1.TXT
- NTFS (1993, Windows NT 3.1)
  - Volume max 256TB-8PB*
  - Max file size: 16EB
  - encryption, compression
  - journaling

Linux and MacOS

- ext2/ext3/ext4
- btrfs
- XFS
- ZFS
- …

- HFS/HFS+
- APFS



Kernel

Virtual File System

EXT3 HPFS VFAT EXT4 FreeBSD

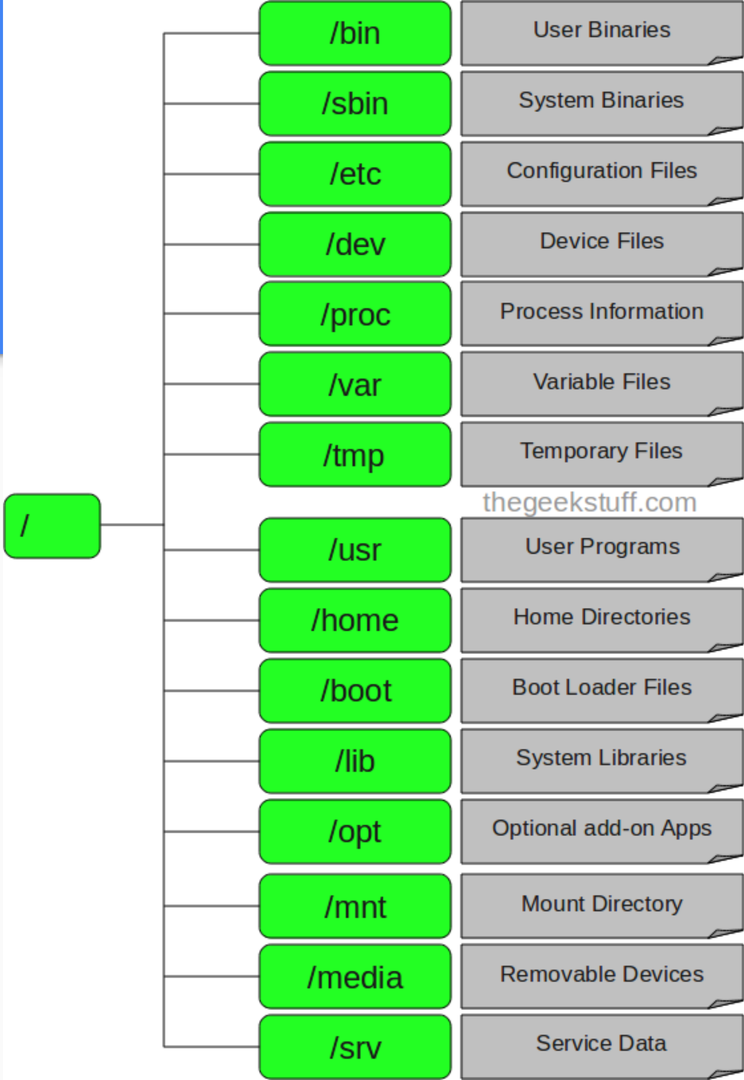
Hardware

Directory/folder

```
$ ls /
```

[Filesystem Hierarchy Standard](https://www.pathname.com/fhs/pub/fhs-2.3.pdf)

https://www.pathname.com/fhs/pub/fhs-2.3.pdf



/

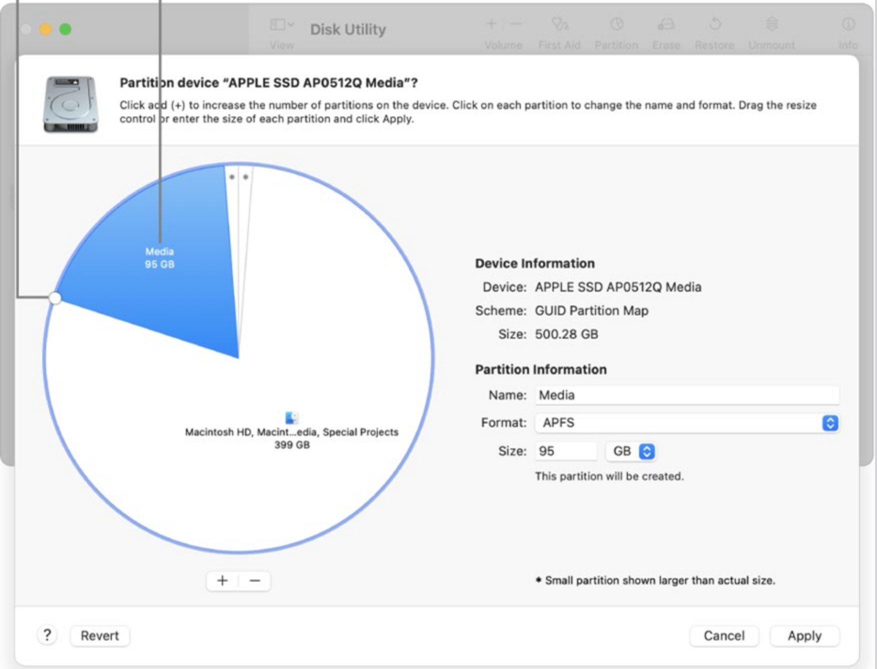
/bin	User Binaries
/sbin	System Binaries
/etc	Configuration Files
/dev	Device Files
/proc	Process Information
/var	Variable Files
/tmp	Temporary Files
/usr	User Programs
/home	Home Directories
/boot	Boot Loader Files
/lib	System Libraries
/opt	Optional add-on Apps
/mnt	Mount Directory
/media	Removable Devices
/srv	Service Data

thegeekstuff.com

Partition vs volume

Drag to resize a volume.

Size of volume



Partition device “APPLE SSD AP0512Q Media”?

Click add (+) to increase the number of partitions on the device. Click on each partition to change the name and format. Drag the resize control or enter the size of each partition and click Apply.

Device Information

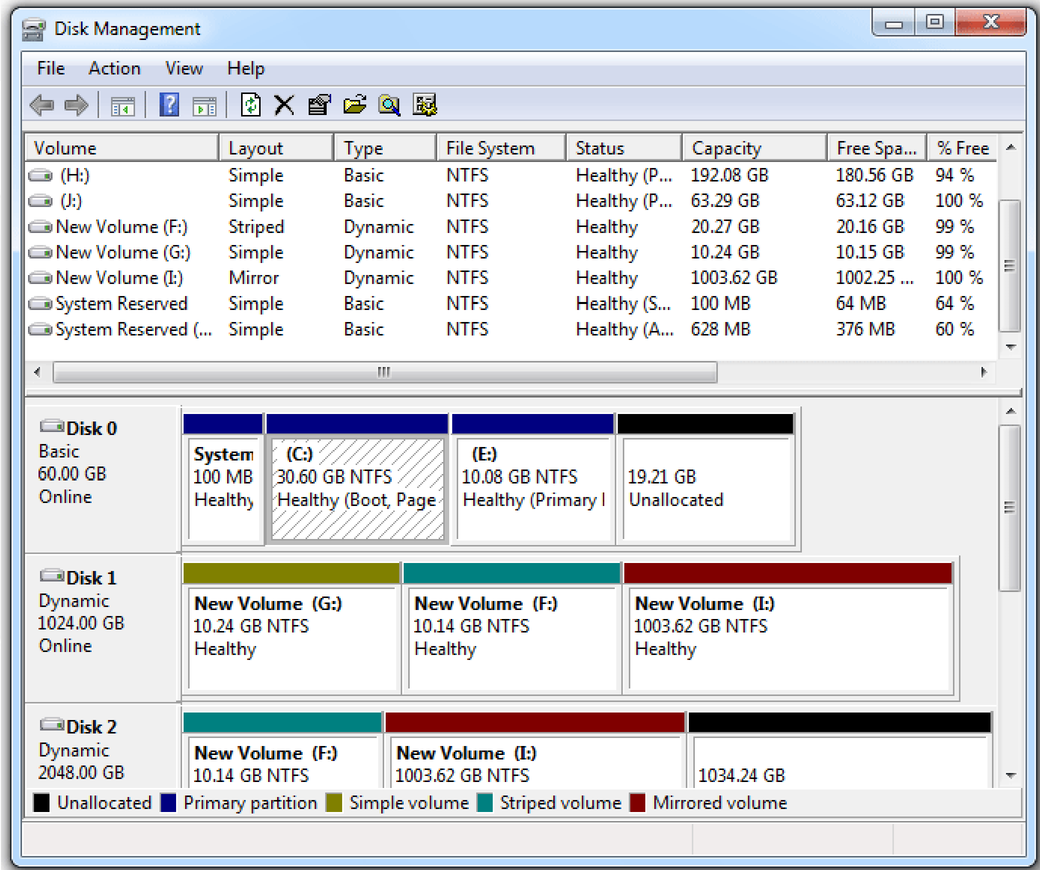
Device: APPLE SSD AP0512Q Media
Scheme: GUID Partition Map
Size: 500.28 GB

Partition Information

Name: Media
Format: APFS
Size: 95 GB

This partition will be created.

* Small partition shown larger than actual size.



Volume	Layout	Type	File System	Status	Capacity	Free Spa...	% Free
(H:)	Simple	Basic	NTFS	Healthy (P...	192.08 GB	180.56 GB	94 %
(J:)	Simple	Basic	NTFS	Healthy (P...	63.29 GB	63.12 GB	100 %
New Volume (F:)	Striped	Dynamic	NTFS	Healthy	20.27 GB	20.16 GB	99 %
New Volume (G:)	Simple	Dynamic	NTFS	Healthy	10.24 GB	10.15 GB	99 %
New Volume (I:)	Mirror	Dynamic	NTFS	Healthy	1003.62 GB	1002.25 ...	100 %
System Reserved	Simple	Basic	NTFS	Healthy (S...	100 MB	64 MB	64 %
System Reserved (...	Simple	Basic	NTFS	Healthy (A...	628 MB	376 MB	60 %

Disk 0
Basic
60.00 GB
Online

- **System** 100 MB Healthy
- **(C:)** 30.60 GB NTFS Healthy (Boot, Page
- **(E:)** 10.08 GB NTFS Healthy (Primary I
- 19.21 GB Unallocated

Disk 1
Dynamic
1024.00 GB
Online

- **New Volume (G:)** 10.24 GB NTFS Healthy
- **New Volume (F:)** 10.14 GB NTFS Healthy
- **New Volume (I:)** 1003.62 GB NTFS Healthy

Disk 2
Dynamic
2048.00 GB

- **New Volume (F:)** 10.14 GB NTFS
- **New Volume (I:)** 1003.62 GB NTFS
- 1034.24 GB

■ Unallocated ■ Primary partition ■ Simple volume ■ Striped volume ■ Mirrored volume

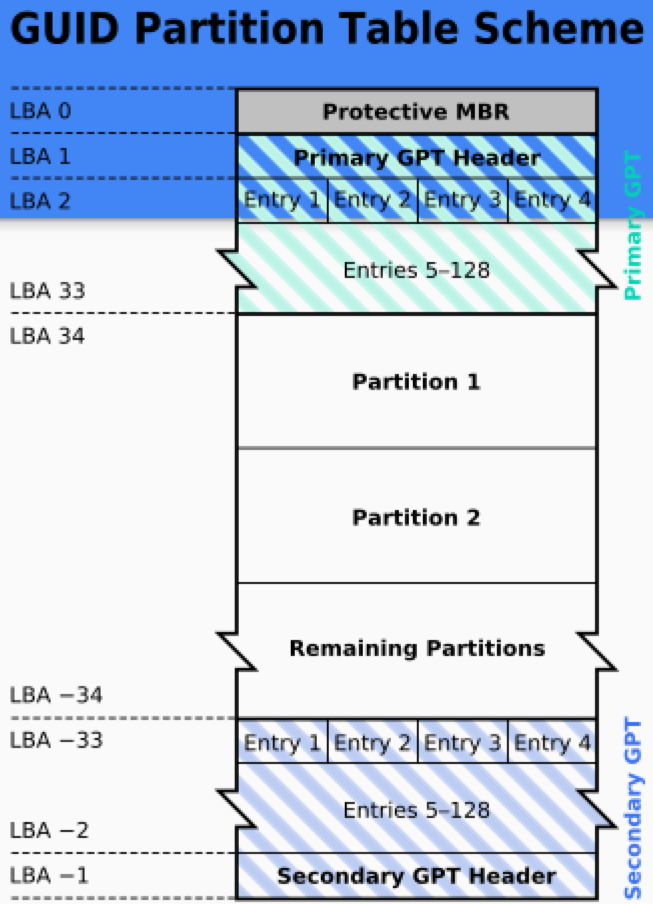
Master Boot Record (MBR) (1983)

- Boot code
  - 16 bit
  - beginning of the disk
- Partition table
  - 4 primary partitions
  - or 3 primary partitions and 1 extended partition (many logical partitions inside)
  - max 2TB disk

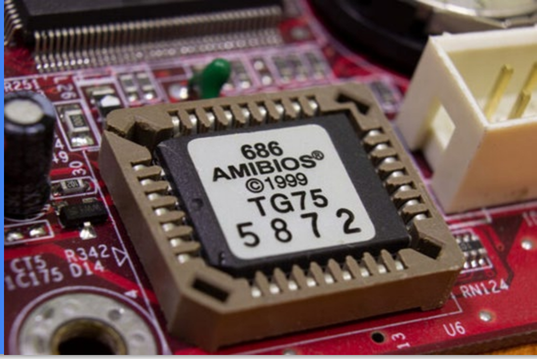
1990s, Intel

GUID Partition Table (GPT)

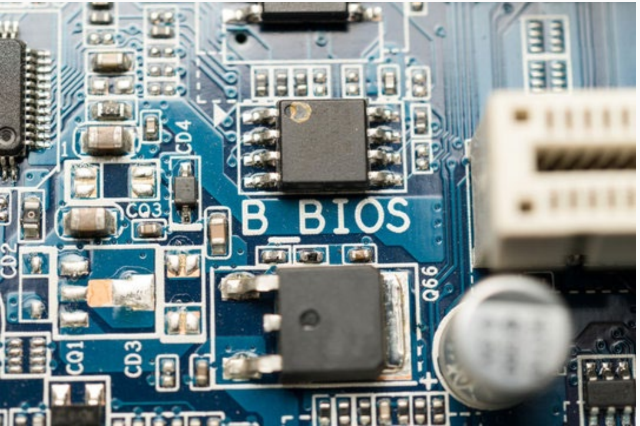
- No boot code
- Stored at the beginning and the end of the disk
- Max 256 partitions
- Max 64ZB disk
- Windows Vista ~ requires UEFI



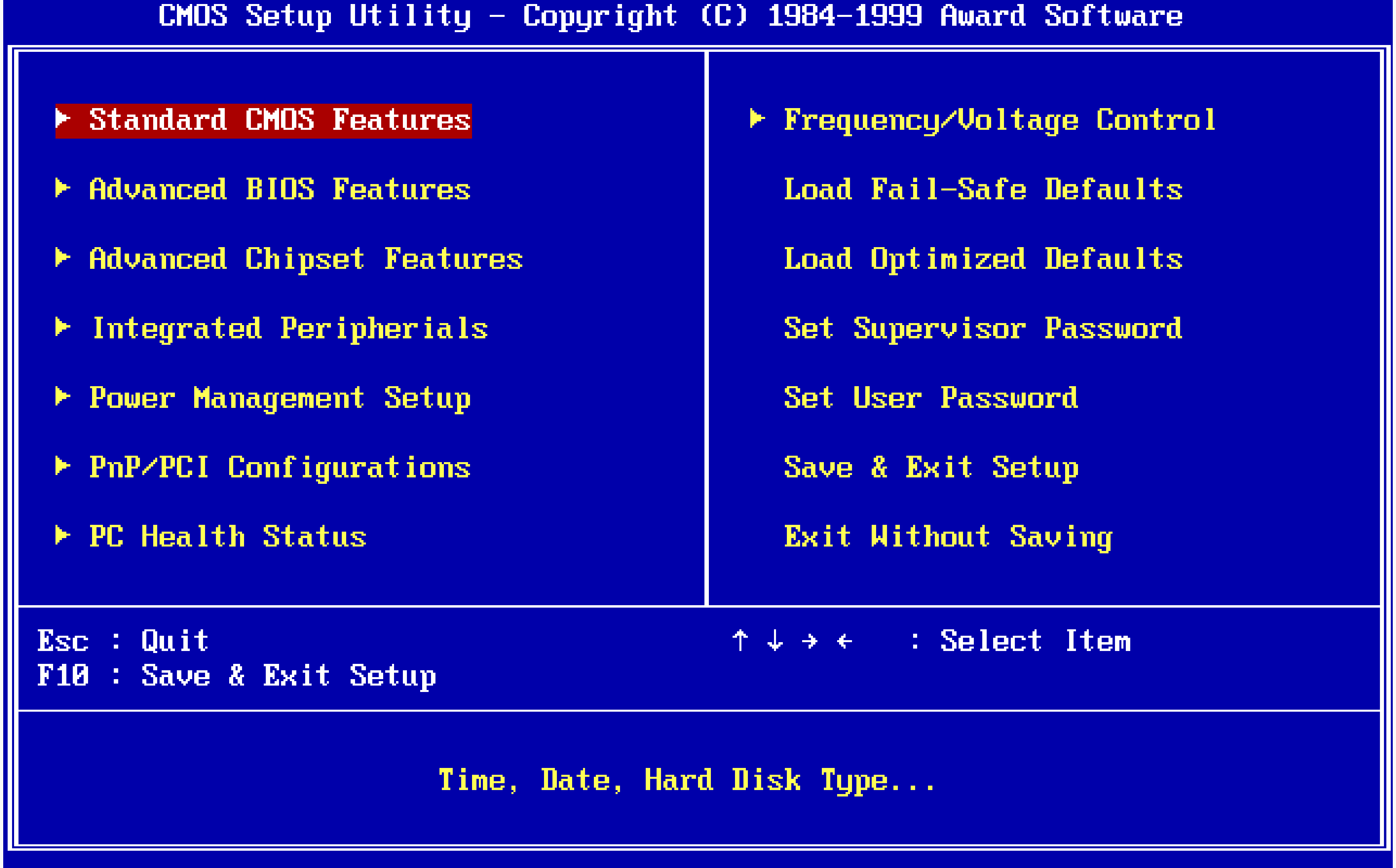
BIOS vs UEFI



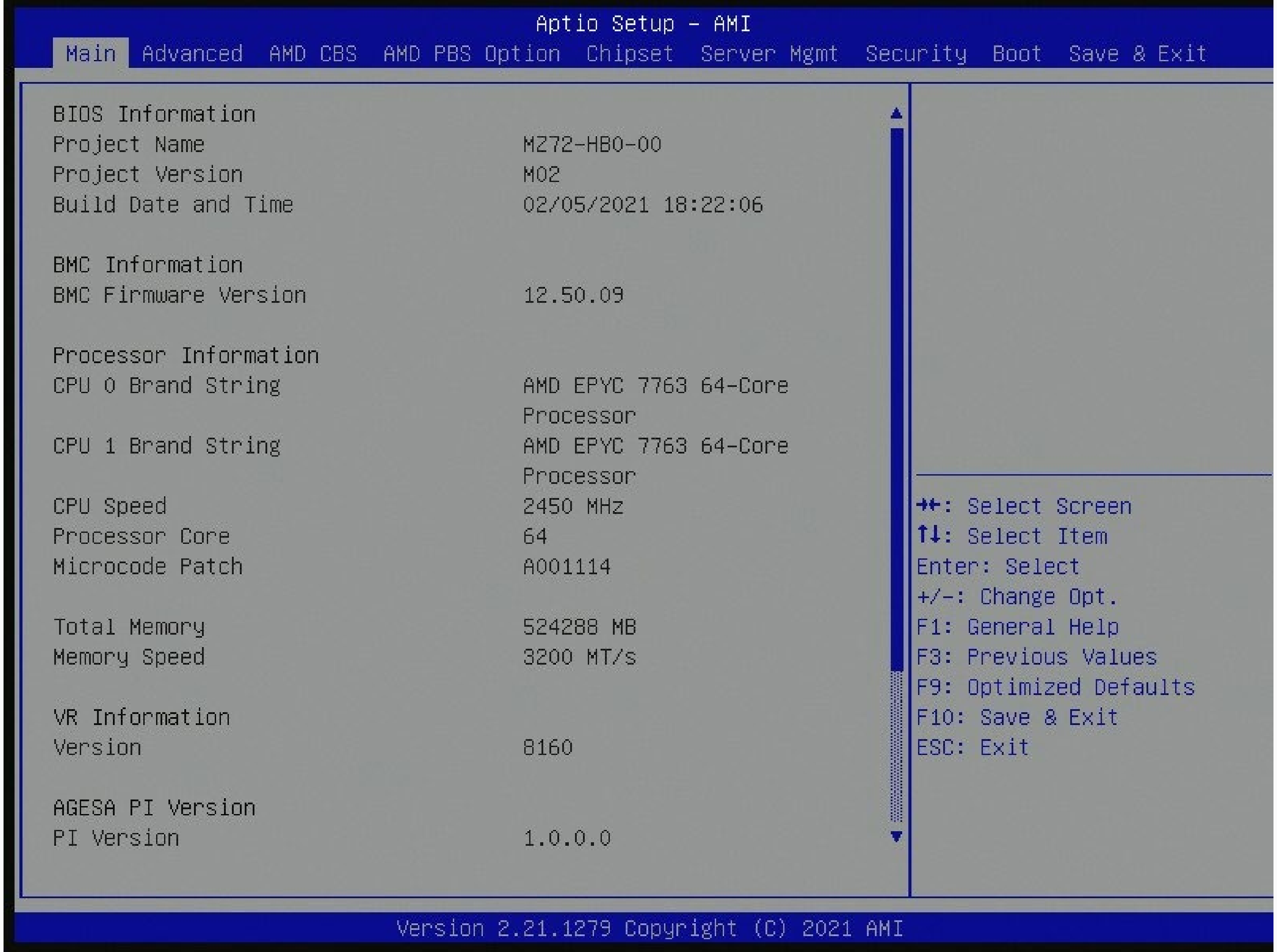
- BIOS (Basic Input/Output System) (1975)
  - initialize hardware, boot OS
  - 16 bit



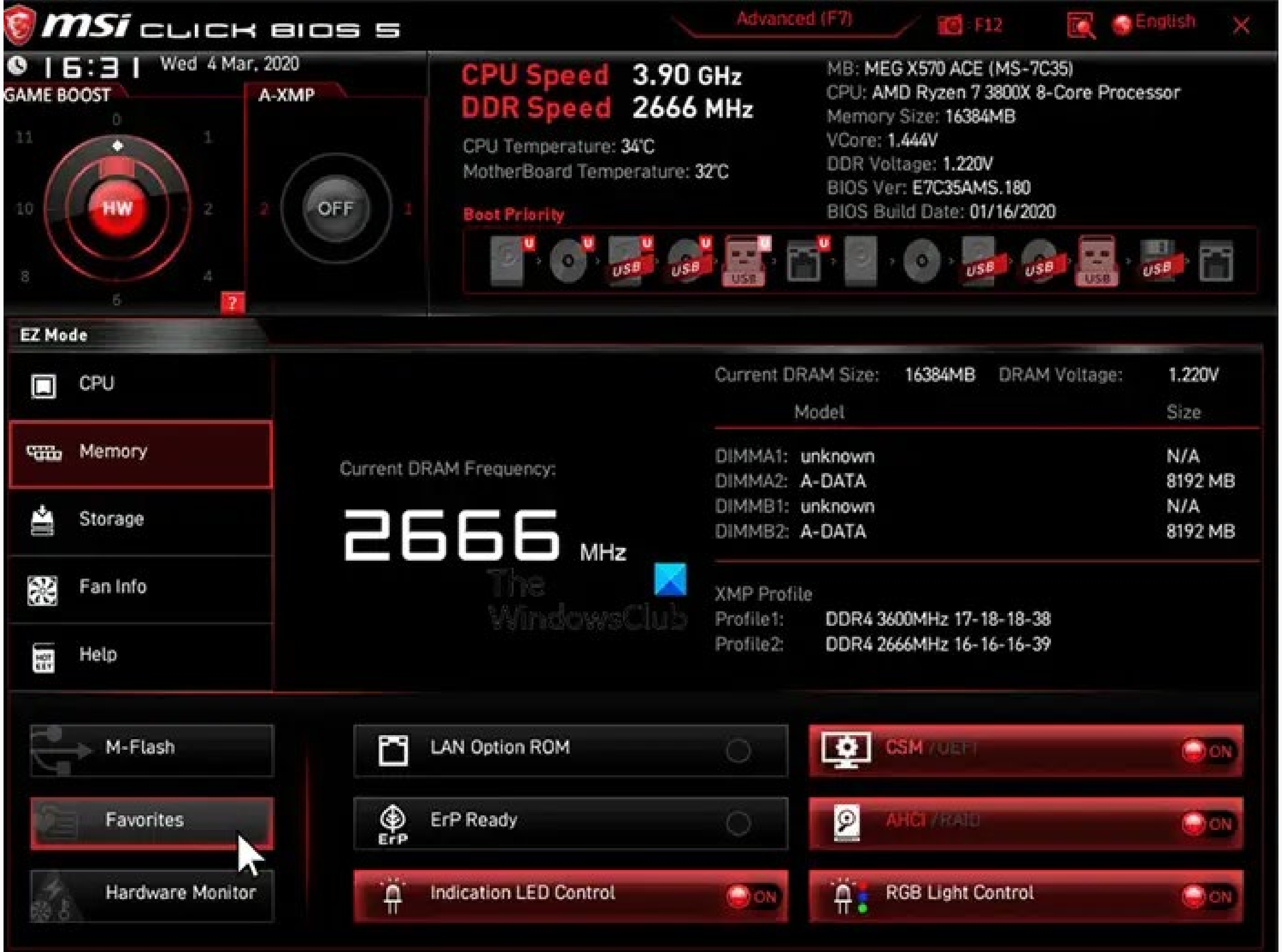
- UEFI (Unified Extensible Firmware Interface) (2004)
  - initialize hardware, boot OS
  - 32/64 bit
  - support GPT
  - support mouse, network, FAT, (NTFS), secure boot*
  - boot from (ESP)/EFI/boot/bootx64.efi
  - support legacy boot using CSM



```
CMOS Setup Utility - Copyright (C) 1984-1999 Award Software

► Standard CMOS Features          ► Frequency/Voltage Control
► Advanced BIOS Features            Load Fail-Safe Defaults
► Advanced Chipset Features         Load Optimized Defaults
► Integrated Peripherials           Set Supervisor Password
► Power Management Setup            Set User Password
► PnP/PCI Configurations            Save & Exit Setup
► PC Health Status                  Exit Without Saving

Esc : Quit                          ↑ ↓ → ←   : Select Item
F10 : Save & Exit Setup

                  Time, Date, Hard Disk Type...
```



```
BIOS Information
Project Name                      MZ72-HB0-00
Project Version                   M02
Build Date and Time               02/05/2021 18:22:06

BMC Information
BMC Firmware Version              12.50.09

Processor Information
CPU 0 Brand String                AMD EPYC 7763 64-Core
                                  Processor
CPU 1 Brand String                AMD EPYC 7763 64-Core
                                  Processor
CPU Speed                         2450 MHz
Processor Core                    64
Microcode Patch                   A001114

Total Memory                      524288 MB
Memory Speed                      3200 MT/s

VR Information
Version                           8160

AGESA PI Version
PI Version                        1.0.0.0
```



CPU Speed 3.90 GHz
DDR Speed 2666 MHz
CPU Temperature: 34°C
MotherBoard Temperature: 32°C

MB: MEG X570 ACE (MS-7C35)
CPU: AMD Ryzen 7 3800X 8-Core Processor
Memory Size: 16384MB
VCore: 1.444V
DDR Voltage: 1.220V
BIOS Ver: E7C35AMS.180
BIOS Build Date: 01/16/2020

Current DRAM Frequency:
2666 MHz

Current DRAM Size: 16384MB DRAM Voltage: 1.220V

	Model	Size
DIMMA1:	unknown	N/A
DIMMA2:	A-DATA	8192 MB
DIMMB1:	unknown	N/A
DIMMB2:	A-DATA	8192 MB

XMP Profile
Profile1: DDR4 3600MHz 17-18-18-38
Profile2: DDR4 2666MHz 16-16-16-39

LAN Option ROM ○
ErP Ready ○
Indication LED Control ON
CSM / UEFI ON
AHCI / RAID ON
RGB Light Control ON

Install Linux

copy + paste text

Bash (**B**ourne **A**gain **SH**ell)

- ls
- man
- cd
- echo
- touch
- mkdir
- touch
- grep
- pwd
- cp
- mv
- rmdir
- rm

- type
- cmp
- diff
- head
- tail
- cat
- more
- less
- sleep
- history
- clear
- ps
- kill

- nano
- ln
- whoami
- useradd (adduser可)
- sudo
- usermod
- userdel
- su
- exit
- passwd
- whatis
- which

- ssh
- curl
- wget
- zip
- unzip
- tar
- find
- chmod
- chown
- ip
- ping
- nslookup

- date
- time
- users
- groups
- uname
- free
- df
- top
- systemctl
- reboot
- shutdown

https://www.youtube.com/watch?v=gd7BXuUQ91w

(bash) shell script

```
#!/bin/bash
```

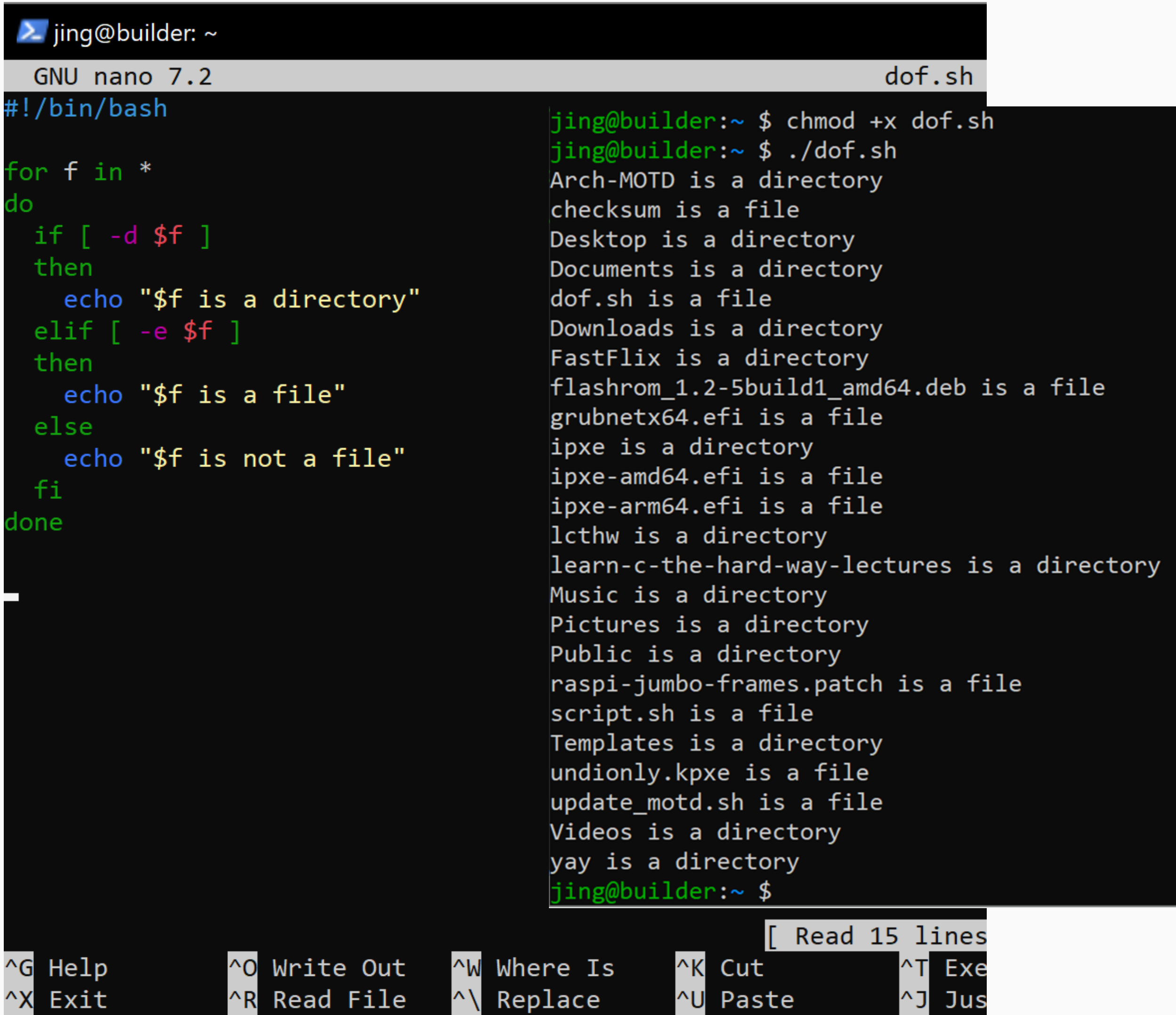
script.sh

```
for (( c=1; c<=5; c++ ))
do
   echo "Welcome $c"
done
```

```
for c in {1..5..1}
do
   echo "Welcome $c"
done
```

```
#!/bin/bash

for f in *
do
  if [ -d $f ]
  then
    echo "$f is a directory"
  elif [ -e $f ]
  then
    echo "$f is a file"
  else
    echo "$f is not a file"
  fi
done
```

The Linux Document Project
https://tldp.org/LDP/Bash-Beginners-Guide/html/sect_07_01.html

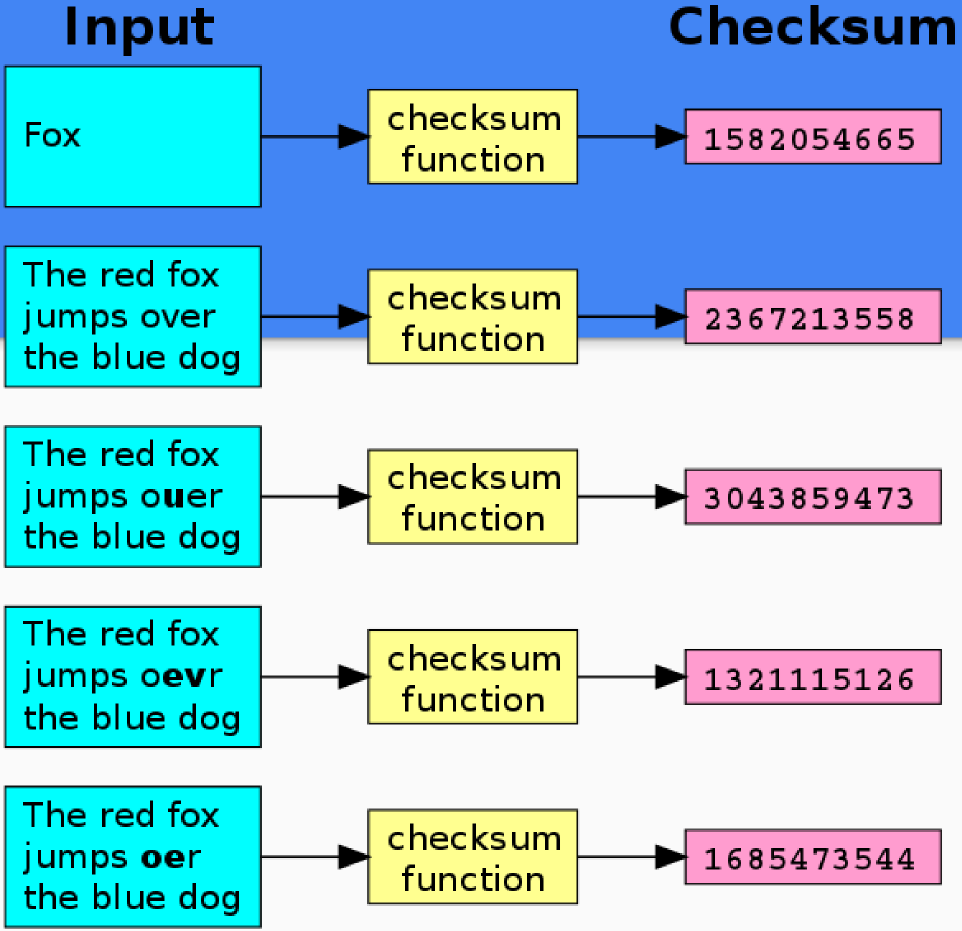


```
GNU nano 7.2                                  dof.sh
#!/bin/bash

for f in *
do
  if [ -d $f ]
  then
    echo "$f is a directory"
  elif [ -e $f ]
  then
    echo "$f is a file"
  else
    echo "$f is not a file"
  fi
done

                                        [ Read 15 lines
^G Help       ^O Write Out   ^W Where Is    ^K Cut       ^T Exe
^X Exit       ^R Read File   ^\ Replace     ^U Paste     ^J Jus
```

```
jing@builder:~ $ chmod +x dof.sh
jing@builder:~ $ ./dof.sh
Arch-MOTD is a directory
checksum is a file
Desktop is a directory
Documents is a directory
dof.sh is a file
Downloads is a directory
FastFlix is a directory
flashrom_1.2-5build1_amd64.deb is a file
grubnetx64.efi is a file
ipxe is a directory
ipxe-amd64.efi is a file
ipxe-arm64.efi is a file
lcthw is a directory
learn-c-the-hard-way-lectures is a directory
Music is a directory
Pictures is a directory
Public is a directory
raspi-jumbo-frames.patch is a file
script.sh is a file
Templates is a directory
undionly.kpxe is a file
update_motd.sh is a file
Videos is a directory
yay is a directory
jing@builder:~ $
```

Checksum & Hash algorithm

- CRC
- CRC64
- MD5
- SHA1
- SHA256
- SHA512
- …



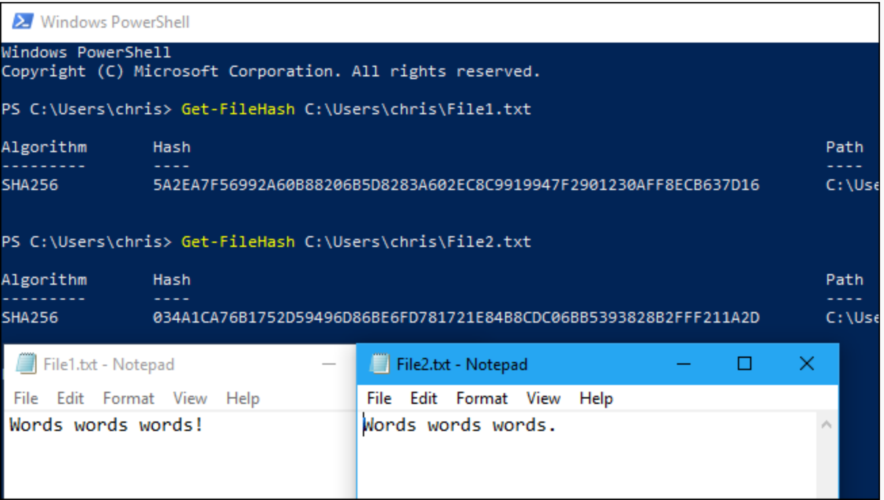
Input		Checksum
Fox	checksum function	1582054665
The red fox jumps over the blue dog	checksum function	2367213558
The red fox jumps **ouer** the blue dog	checksum function	3043859473
The red fox jumps **oevr** the blue dog	checksum function	1321115126
The red fox jumps **oer** the blue dog	checksum function	1685473544

SHA256

- `Get-FileHash C:\file.txt`
  `-Algorithm SHA256`

https://man7.org/linux/man-pages/man1/sha256sum.1.html

```
$ sha256sum file.txt

$ echo -n "foobar" | sha256sum



$ sha256sum file.txt > file.txt.checksum

$ sha256sum -c file.txt.checksum
```



```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

PS C:\Users\chris> Get-FileHash C:\Users\chris\File1.txt

Algorithm       Hash                                                                   Path
---------       ----                                                                   ----
SHA256          5A2EA7F56992A60B88206B5D8283A602EC8C9919947F2901230AFF8ECB637D16       C:\Use


PS C:\Users\chris> Get-FileHash C:\Users\chris\File2.txt

Algorithm       Hash                                                                   Path
---------       ----                                                                   ----
SHA256          034A1CA76B1752D59496D86BE6FD781721E84B8CDC06BB5393828B2FFF211A2D       C:\Use
```

Words words words!

Words words words.

Exercise: write a shell script

Calculate the SHA256 hash of every file in a directory, and store the hash in a file.