

How to install Windows system on your smart phone?

Project report

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Special Thanks

Without the help of the following person

I unable accomplish my project

I would like to thank the following people who have helped me in the
process of completing my project

Bernadette Edge

Yu zhang

All team members of Renegade Project

Geekerwan

Zack Zhang

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Introduction

Topic background

This project is aimed to design and make a product that could run Windows system on your smartphone (SOC¹: snapdragon 845) and help meet some light mobile office needs for people, meanwhile my artefact could also realize the local switch of Android system and Windows System, which means you could switch to Android system to order some food or drinks to have a break after your work or have a phone call at any time you want. And my product aimed to provide a lower cost other than the normal laptop in the market. Otherwise , we could also turns your old smartphone into a new personal computer for you.

Summary of previous achievements

When I initially started to query the project data, I found that some pioneers were already working on the project of how to install the windows system on the mobile phone. Among them, the most representative one was the *Renegade Project* team, which also provided the necessary driver for system installation and UEFI² bootloader. However, according to my observation, although they successfully installed windows on their mobile phones, there was no further research after testing the performance.

Thesis statement

Therefore, in my project, I will be more inclined to the actual use of the system after installation. You can clearly understand how it works and how it helps people to carry out some mild office or entertainment, and at the same time, I will made it portable and cheap

¹ SoC: Abbreviation of *System on Chip*. It is to integrate the key components of the system on a chip.

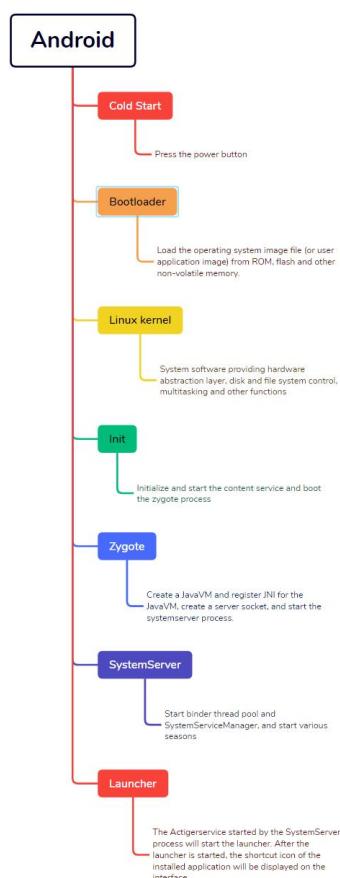
² UEFI: the full name of *Unified Extensible Firmware Interface*, namely "Unified Extensible Firmware Interface", is a standard that describes new types of interfaces in detail, is a standard firmware interface applicable to computers, and is intended to replace BIOS (basic input/output system). This standard was created by more than 140 technology companies in the UEFI Alliance, including Microsoft. UEFI aims to improve software interoperability and solve the limitations of BIOS.

Chapter 1: Preparation in advance.

1.1 Feasibility Investigation.

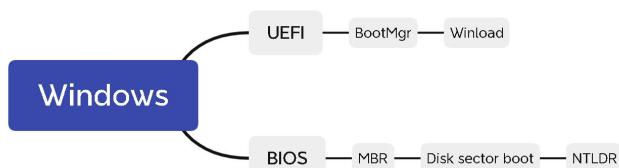
For Android mobile phone processors designed based on ARM architecture, it seems impossible to install a computer system designed based on X86 architecture, because different architectures will lead to different hardware driving logic of the original system.

However, after my comprehensive information collection on the network, I



found that Windows natively provides a version designed for ARM³ processors, and there are also laptops with ARM based Snapdragon processors on the market. This also provides me with the possibility to find the interface layer between software and hardware -- the driver.

To install the computer system on Android phones, I need to analyze the startup process of both parties.



These two pictures introduce the boot process of Windows system and Android system

³ ARM: *Advanced RISC Machine*, was earlier called Acorn RISC Machine, which is a 32-bit RISC(32-bit reduced instruction set) processor architecture.

The main tasks of Android phone boot loader include: setting operation parameters, checking mobile phone hardware, loading preparation programs, verifying firmware signature, etc.

The startup program of a computer, UEFI/BIOS⁴, is also similar to the Bootloader. It also needs to detect hardware and set environment parameters. The difference is that compared with the Bootloader, UEFI is more integrated and has more functions.

Therefore, to start Windows on Android phones, we need to load UEFI at the bootloader stage of the phone in order to replace the original boot to the Linux kernel and boot to the Windows image.

But I soon found the problem. Normally, the mobile phone's bootloader cannot load the computer's UEFI. This is because in order to ensure the security of mobile devices, UEFI firmware cannot be signed by the manufacturer.

To solve this problem, I found a solution in a geek forum on the network: use the edk2 editor to disguise UEFI as the Linux kernel of the phone, so that the phone can successfully load UEFI in the bootloader phase, and complete the boot of the Windows system image.

So far, the project has been confirmed as feasible.

1.2 Literature review

Modularization, as a new method to solve complex problems, can make the design scheme more diversified, better deal with the uncertainty of design, and make the production process and organizational efficiency more efficient. Therefore, it is being used more widely in different fields and becomes the essence of the new industrial structure(Yan & Li, 2007:abstract).

⁴ BIOS:Abbreviations of "Basic Input Output System",It is a set of programs solidified to a ROM(Read-Only Memory) chip on the motherboard of the computer.

A modular design framework of product service system (PSS) for large-scale personalization is proposed. Through the combination of internal modules of physics and services, large-scale, personalized, low-cost and rapid provision of customer needs can be achieved.(Li, Tao, Wen, Wang & Luo, 2018:p1)

From the descriptions of the advantages of modular design in the above two paragraphs, I find that this actually coincides with the design concept of Windows phone: to meet the personalized needs of users, to provide quickly, and to better deal with the uncertainty of design. From various perspectives, modular design will play an important role in my entire project.

After defining the design concept, I will first purchase the most basic equipment, and then provide personalized design solutions for customers after user experience research.

1.3 Device purchases

1.3.1 Host mobile phone selection

In order to realize the performance release of hardware after Windows installation and the input of portable screen, there are two main requirements for the host:

- 1.SOC was once used as the processor of regular notebook computers, so you can find the appropriate driver.
2. Type-c⁵ interface has video signal transmission capability, that is, full function Type-c.

For the above two standards, after I systematically counted the computers and mobile phones of Snapdragon processors, I locked the Smartisan R1, a product once produced by Smartisan.

⁵ Type-C is a USB interface appearance standard, which is smaller than Type-A and Type-B, and can be applied to both PC (master device) and external devices (slave device, such as mobile phone)



Mobile phone purchase transactions

So I started to select and purchase the phone in the second-hand market, and finally bought the phone at 560CNY(about 72 pounds)

1.3.2 OTG⁶ expansion dock

There are Four requirements for the purchase of the expansion dock:

- 1.HDMI⁷ interface for video transmission;
2. type-c interface for connecting mobile phones;
3. PD⁸ power supply function, which can supply power for mobile phones when they are in use.
4. It has multiple USB⁹ interfaces, which can connect the mouse, keyboard operating system, and the mobile hard disk to install Windows images.



⁶ OTG: The abbreviation of On The Go, which is mainly used to connect different devices or mobile devices for data exchange.

⁷ HDMI: High Definition Multimedia Interface.It is a full digital video and sound transmission interface, which can send uncompressed audio and video signals.

⁸ PD: USB Power-delivery (USBPD), which is one of the main fast charging protocols at this stage.

⁹ USB: Universal Serial Bus.It is an external bus standard used to regulate the connection and communication between computers and external devices.

Expansion dock station I bought

The above figure shows the docking station I bought at TAOBAO online shopping website for 140 yuan.

1.3.3 Keyboard and mouse.

There is no hard standard for keyboard and mouse. For me, it will be more convenient to use the keyboard and mouse connected wirelessly through 2.4GWIFI adapter. However, it should be noted that before the formal installation of Windows completed, it is not feasible to use Bluetooth to connect the mouse or keyboard in the PE system. This is because there is no special driver for Bluetooth installed in the PE system.

1.3.4 Portable Screen

There are various portable screens on the market. For this project, a display screen with a built-in battery is more convenient to use, and it does not necessarily need to be connected to the charging bank at all times. For other parameters, it is recommended to purchase a 1080p 14 inch screen. The advantages of this choice are as follows:

- 1.The pixel density is sufficient relative to the screen size, so you won't feel unclear when using it.
2. Small screen size, easy to carry.

1.3.5 Mobile hard disk or USB stick.

The mobile storage device is necessary during the installation of the system, and it is also recommended to use the mobile storage device to store the necessary software or data in the subsequent use of the system. Therefore, in order to release the stored Windows 11 image files to the mobile phone hard disk normally, I need a hard disk with a capacity of more than 8GB and compatible with OTG technology to connect the mobile phone.

Table 1: Component of Windows phone Price List

	Cost (CNY)	Cost (GBP)
Smartphone	600	74
Keyboard	100	12
Mouse	100	12
Screen	800	99
Expansion Dock	100	12
Displaylink Dock	200	24
Total	1900	233

Price summary (due to the fluctuation of the secondary market price and the different purchase needs of each person, the prices in this figure are only for reference)

Chapter 2: Market Demand Survey.

2.1 Questionnaire Design

After solving the basic installation requirements, I designed a questionnaire containing nine questions to understand the market demand for portable electronic devices and what these requirements are from the aspects of "user preferences" and "user scenarios". The importance of this questionnaire in my whole project is decisive, which directly defines my modular design concept, that is, to meet the needs of more people as far as possible under the condition of controllable cost.

[See the attachment "Questionnaire Wesley" for the specific statistical results.](#)

2.2 Propagation

After the questionnaire design is completed, I immediately use QQ to spread my

答卷总数

567 ◎

位置分布



questionnaire to the teachers and students of the school and ask the teachers of the school admission office to help spread it to the group chat of middle schools throughout the city. Furthermore My mother is a university teacher. Under her promotion, my questionnaire was

also spread among alumni of many universities, and more than 300 questionnaires were collected in one day. Finally, one week later, the number of questionnaires collected approached saturation and 561 results were finally harvested.

In a word, middle school students, college students and teachers are more representative of my survey population

2.2 Conclusion of the questionnaire

Among my Questionnaire about *The demand of portable electronic device*, three main problems reveal the large demand for portable electronic devices in the market:

- *What kind of operating system your tablet or laptop you usually use?*
- *What do you usually do with your laptop or tablet?*
- *Are you willing to buy or buy more tablets or laptops?*

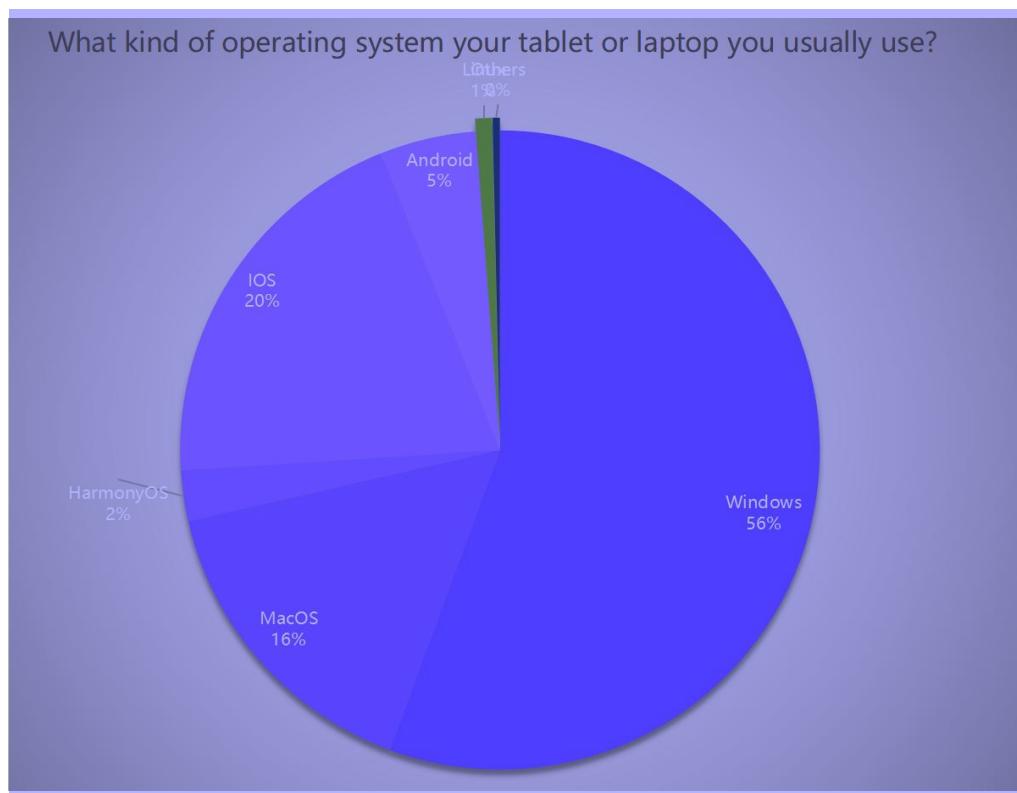


Fig 1: Windows:457 MacOS:130 HarmonyOS:21
iOS:164 Android:40 Linux:7 Other:3

What do you usually do with your laptop or tablet?

■ Total number of people answering this question: 540

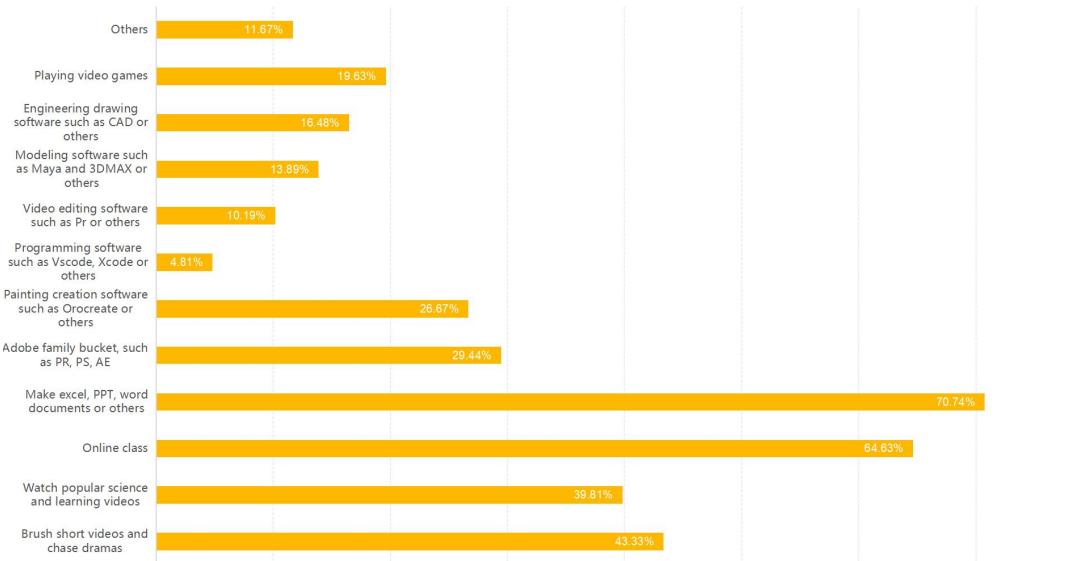


Fig 2: See the following table for specific data

*Table 2: Specific data for the question:
"what do you usually do with your laptop or tablet?"*

6. What do you usually do with your laptop or tablet?

Brush short videos and chase dramas	234	43.33%
Watch popular science and learning videos	215	39.81%
Online class	349	64.63%
Make excel, PPT, word documents or others	382	70.74%
Adobe family bucket, such as PR, PS, AE	159	29.44%
Painting creation software such as Orotate or others	144	26.67%
Programming software such as Vscode, Xcode or others	26	4.81%
Video editing software such as Pr or others	55	10.19%
Modeling software such as Maya and 3DMAX or others	75	13.89%
Engineering drawing software such as CAD or others	89	16.48%
Playing video games	106	19.63%
Others	63	11.67%
Number of valid persons to fill in this question	540	

Are you willing to buy or buy more tablets or laptops?

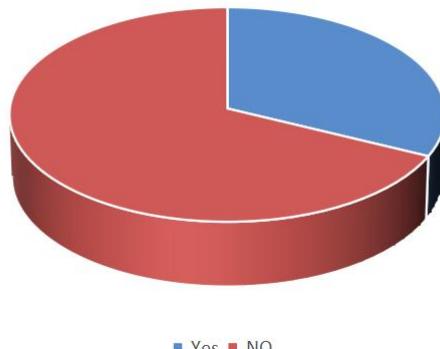


Fig 3: Yes:182 No:384

According to the above chart, we can draw three main conclusions clearly and intuitively:

1. A lot of people who use portable electronic devices have the need to use Windows system.
2. Most people do not need high performance when using electronic devices.
3. Nearly one third of the population still has the need to replace portable electronic devices.

In a word, there are a large number of people in the market who want to buy portable electronic devices loaded with Windows systems, and they do not need high-performance requirements.

And this perfectly matches my product's expectation for the market: Windows phone.

Chapter 3: Installation of the Windows 11 system.

3.1 Unlock the phone and install unofficial Recovery.

Generally, mobile phone manufacturers will encrypt the startup process of mobile phones to prevent criminals from stealing others' mobile phones to crack the system

and then selling them for profit. The encryption startup process is the core part of BootLoader Lock (hereinafter referred to as BLL). For some mobile phone manufacturers, such as XIAOMI and MEIZU, using their official websites can also follow the formal process to unlock the BLL, thus opening more mobile phone permissions to some geeks, so that these geeks have more operating permissions on their mobile phones, commonly known as phone swiping.

However, for the sake of higher security, other mobile phone manufacturers such as Smartisan do not have the official permission to unlock BLL. However, some private geeks have also provided the unlocking scheme: 9008 Deep Brush.

Port 9008 is a mode designed by processor manufacturer Qualcomm for system recovery, EDL¹⁰. In this special mode, it is possible to bypass BLL for system file flushing.



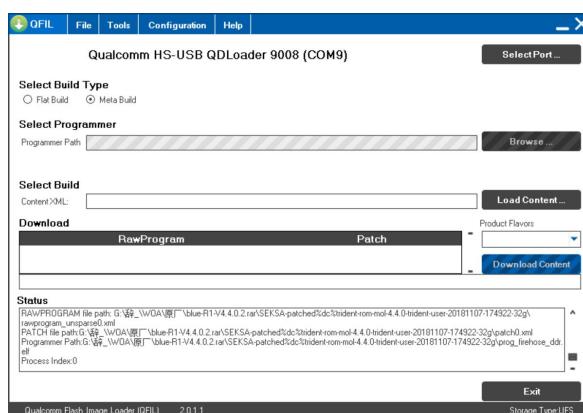
Internal structure of Smartisan R1 mobile phone

In order to enter this mode, I disassembled the phone and found the contacts reserved on the motherboard for entering the EDL mode. After shorting the contacts with metal tweezers, I successfully entered the EDL mode.

¹⁰ EDL: [Emergency Download Mode](#).

However, when the unlock file and unofficial recovery are flushed in (For mobile phones, Recovery is a mode provided by Android mobile phones that can modify the internal data or system of the mobile phone, a bit like DOS¹¹ under Windows operating system. After the mobile phone enters Recovery, it can restore the phone to factory settings, upgrade the system of the mobile phone, refresh the mobile phone, and so on. Recovery not officially provided by the mobile phone manufacturer, such as TWRP, has a more user-friendly graphical operating interface and a more powerful Function), I found that I was stuck in EDL mode, that is, the phone is completely blank.

In order to solve this problem, I asked a large number of geeks on various geek forums and in geek group conversations, and they gave me the same solution, such as disassembling the phone, unplugging the power cord for cold start or using ADB¹² commands to force the phone to restart. However, after many unsuccessful attempts at these solutions, I decided to pay professionals for help.



Finally, I bought their remote installation service at a Taobao online store for 30 yuan, and successfully entered the system with their help. After that, I analyzed their installation process and judged that I had taken the system offline or damaged it when I first entered the EDL mode for machine brushing due to misoperation, which made

¹¹ DOS:*Disk Operation System*, It is an operating system on early personal computers.

¹² ADB:*Android Debug Bridge*, It is an android debugging tool, which can be used to connect the computer end to the android system through this tool for a series of operations, such as installing packages, running debugging commands, controlling the system, etc.

it impossible to boot the phone normally and enter the system. The phone can only enter the EDL mode. But after that, I learned how to use the EDL mode to recover my system when the system failed through their services.

3.2 Hard disk partition

To install Windows on a mobile phone and switch between Windows and Android, we need to create four hard disk partitions to store:

1. Windows boot file UEFI
2. PE system used to release Windows image files and install hardware drivers (that is, a deeply simplified version of Windows system, similar to Recovery in a mobile phone).
3. Windows system files (C: disk in the computer).
4. Android system files.

```
cp /sdcard/parted /sbin/ && chmod 755 /sbin/parted
umount /data && umount /sdcard
parted /dev/block/sda
rm 17                      # remove userdata
mkpart esp fat32 6559MB 7000MB      # 441 MB
mkpart pe fat32 7000MB 10000MB     # 3 GB
mkpart win ntfs 10000MB 70GB       # 61,680 MB ( 61.68 GB )
mkpart userdata ext4 70GB 125GB    # 56,320 MB ( 56.32 GB )
set 17 esp on                  # mark as active partition
quit
```

Create a new partition for phone's hard disk

In actual operation, we need to use a mobile phone to connect to the computer, enter TWRP, and use the command prompt line (CMD) to enter the following command to complete the creation of a new cell phone partition.

After that, we need to enter the following code in order to format each newly created partition (Formatting refers to an operation to initialize a disk or partition on a disk. This operation usually results in all files on the existing disk or partition being erased.)

```
mkfs.fat -F32 -s1 /dev/block/by-name/pe  
mkfs.fat -F32 -s1 /dev/block/by-name/esp  
mkfs.ntfs -f /dev/block/by-name/win  
mke2fs -t ext4 /dev/block/by-name/userdata
```

However, an error occurred during the actual operation. The error code is as follows.

```
trident:/ # mke2fs -t ext4 /dev/block/by-name/userdata  
mke2fs -t ext4 /dev/block/by-name/userdata  
mke2fs 1.43.3 (04-Sep-2016)  
/dev/block/by-name/userdata contains a ext4 file system  
    last mounted on /data on Thu Jan  1 06:55:11 1970  
Proceed anyway? (y, n) y  
y  
/dev/block/by-name/userdata is apparently in use by the system; will not make a filesystem here!  
1|trident:/ #
```

Hard disk formatting error

The error result shows that the ext4 format partition we created for Windows is already in use, and a new system cannot be created.

In this regard, a geek forum(CSDN¹³) respondent analyzed the problem and gave a possible solution:

linux格式化硬盘时出现错误,格式化硬盘出现/dev/sdb5 is apparently in use by the system错误...

错误如下: [root@hpf-linux-~]# mke2fs -t ext3 -b 2048 -m 3 /dev/sdb5
mke2fs 1.41.12 (17-May-2010)

/dev/sdb5 is apparently in use by the system; will not make a filesystem here!

提示/dev/sdb5 正在被使用。/dev/sdb5 正在被DM管理，所以我们创建文件系统时提示报错，我们手工的移除，就可以正常的创建文件系统，操作如下: [root@hpf-linux-~]# cat /proc/partitions

Answers given by a respondent on the CSDN forum on the above contents of the article

(https://blog.csdn.net/weixin_42387319/article/details/116733204)

¹³ CSDN: Chinese software develop net

The respondent believes that the reason for this is that the partition has been occupied and managed by DM¹⁴, and dmsetup remove is needed to solve this problem. The format can be completed normally after the all command removes the DM occupation.

Use the # cat/proc/partitions command to query, It is found that a hard disk partition is occupied by DM, as the respondent said.

8	34	128	sdc2
8	80	1572864	sdf
8	81	104	sdf1
8	82	2048	sdf2
8	83	2048	sdf3
8	84	2048	sdf4
8	85	128	sdf5
253	0	37153792	dm-0

a hard disk partition is occupied by DM

During the actual operation of the solution given by the owner, I found that there was no dmsetup command in the preset command set of my mobile phone.

```
trident:/ # dmsetup remove_all  
dmsetup remove_all  
/sbin/sh: dmsetup: not found
```

Dmsetup command not found

In order to solve this problem, I searched again in CSDN. An article from another respondent provided me with ideas. I can use the yum command to add a dmsetup command to the instruction set.

¹⁴ DM: Disk Manager



A respondent's description of the yum command on the CSDN forum

But the problem arises again. There is no preset of yum command in the instruction set.

After many attempts, I found that although I could not format the new partition, I could delete it.

So I changed a solution. Since I can't format the partition, I delete the partition and format the entire hard disk.

I recorded the original 15 partitions of the hard disk and the four partitions I created, and then formatted the whole hard disk.

Later, I returned to the EDL mode. However, after learning in the last section, I learned how to solve this problem. After successfully installing TWRP¹⁵, I created four partitions again. This time, my formatting succeeded.

```
命令提示符 - adb shell
Microsoft Windows [版本 10.0.19042.1052]
(c) Microsoft Corporation。保留所有权利。
C:\Users\chu_y\adb shell
OnePlus6T:/ # mkfs.fat -F32 -s1 /dev/block/by-name/pe
mkfs.fat -F32 -s1 /dev/block/by-name/pe
mkfs.fat 3.0.28 (2015-05-16)
OnePlus6T:/ # mkfs.fat -F32 -s1 /dev/block/by-name/esp
mkfs.fat -F32 -s1 /dev/block/by-name/esp
mkfs.fat 3.0.28 (2015-05-16)
OnePlus6T:/ # mkfs.ntfs -f /dev/block/by-name/win
mkfs.ntfs -f /dev/block/by-name/win
Cluster size has been automatically set to 4096 bytes.
Creating NTFS volume structures.
mkntfs completed successfully. Have a nice day.
OnePlus6T:/ # mke2fs -t ext4 /dev/block/by-name/userdata
mke2fs 1.43.3 (04-Sep-2016)
Discarding device blocks: done
Creating filesystem with 163584 4k blocks and 40960 inodes
Filesystem UUID: 8c2950df-6e86-4977-bfa3-16889c0d8eca
Superblock backups stored on blocks:
      32768, 98304

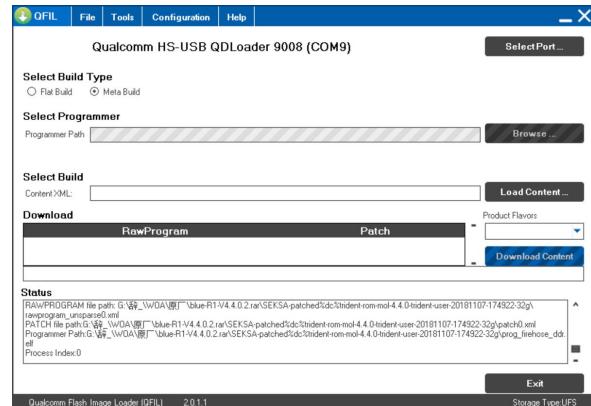
Allocating group tables: done
Writing inode tables: done
Creating journal (4096 blocks): done
Writing superblocks and filesystem accounting information: done
```

formatting succeeded.

¹⁵ TWRP is a tool developed by foreign Android enthusiasts. Its full name is [TeamWin Recovery Project](#).

3.3 Install Android system

The process of installing Android is much less complex than Windows. I need to enter the EDL mode first, then use the data cable to connect the phone and computer, and then use the



QFIL¹⁶ tool to push the prepared system files to complete the installation of the system.

3.4 Install Windows system.

Before installing the Windows system, we need to install the PE¹⁷ system first in order to release system image.

Use the mount command to mount the PE to the/mnt partition. The purpose of this step is to tell the phone that I want my PE partition to be installed in the newly created folder.

```
mount /dev/block/by-name/pe /mnt
```

Use the OTG connection to download the PE system to the USB flash drive in advance, and use the cp command to copy the PE file to the PE partition

```
cp -r /usbstorage/20h2pe_new/* /mnt
```

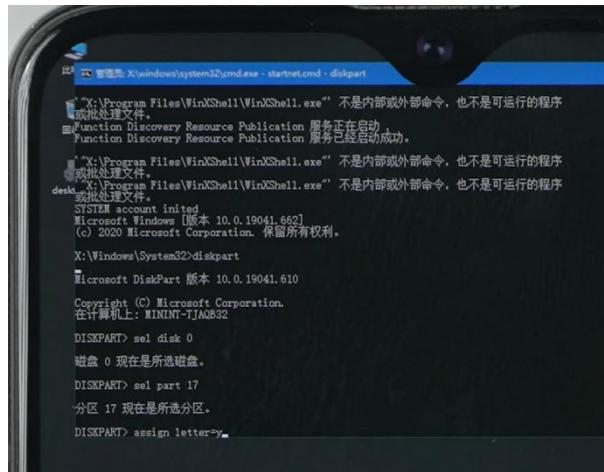
1. Enter Fastboot mode and use the prepared UEFI as the boot file for the next boot

¹⁶ QFIL: *Qualcomm Flash Image Loader*, Qualcomm's burning tool.

¹⁷ PE: *Microsoft Windows Pre-installation Environment*.

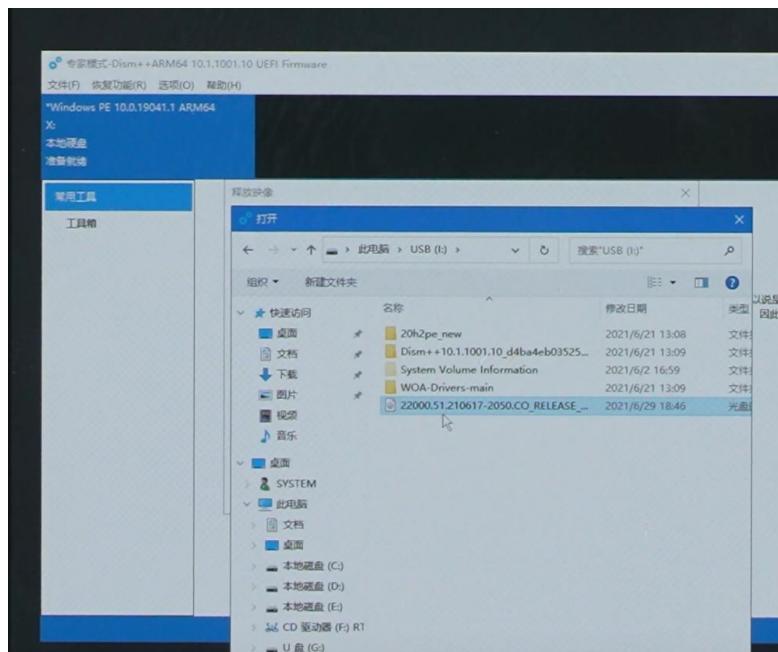


2. Mount the esp partition and tell the system that I want to release my windows image files in the esp partition



Mount the esp(For storage UEFI) partition

3. Open Dism++¹⁸ to release the system image file



release the system image file

¹⁸ Dism++: A System maintenance tools.

4.Close the device driver signature and install the driver we prepared.

```
bcdedit /store Y:\efi\microsoft\boot\bcd /set {Default} testsigning on  
bcdedit /store Y:\efi\microsoft\boot\bcd /set {Default} nointegritychecks on
```

Command to turn off driver signature: bcdedit

4. Enter the shutdown - s - t command to restart the device and enter the complete Windows11 system



Windows installation succeeded

Chapter 4: Comprehensive Test

4.1 Performance test (pt.)

Introduction

In this section, I have conducted five tests on the performance of the equipment. And Evaluated the performance of my equipment from five dimensions:

1. Comprehensive performance of CPU¹⁹ and GPU²⁰ for the overall operation

¹⁹ CPU: *Centre processing unit*

²⁰ GPU: *Graphic processing unit*

capability of the equipment directly determines what sorts of work can be done.

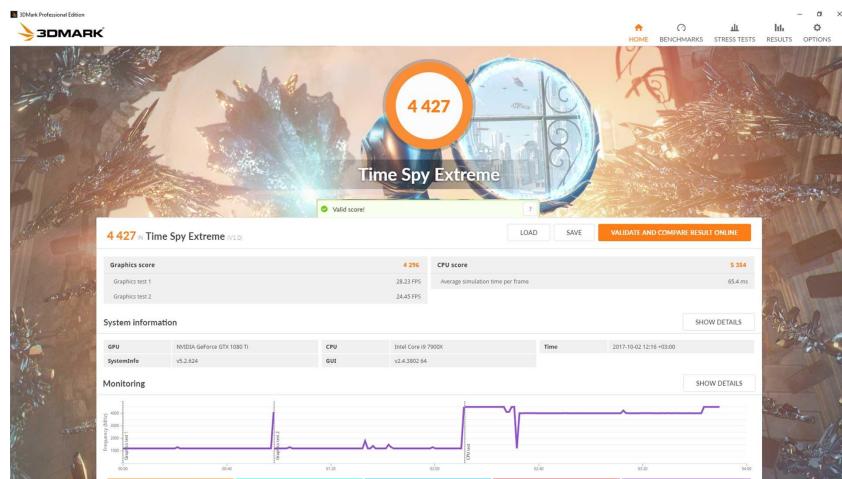
2. Hard disk test that determine the response speed of system operation.
3. CPU test for device computing performance.
4. GPU test for device graphic computing performance.
5. Endurance test, the continuous operation time of the equipment under normal use.

The software used in the test process will be shown below.

Please refer to the attached table "Performance test" for the specific data statistics results and reference hardware score.

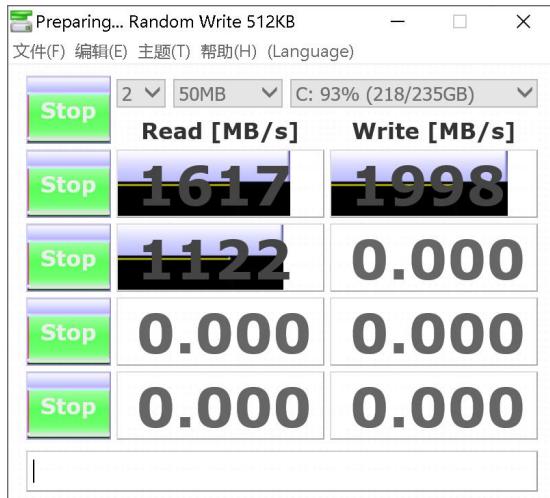
4.1.1 CPU and GPU pt.

In this test, I selected 3Dmark, a software specially designed to measure the performance of video cards from company Futuremark. At present, it has moved towards overall host testing.



Timespy test item in 3Dmark(note: this score is not a native test score, but only a software demonstration)

4.1.2 Disk pt.



CrystalDiskMark: Software that test the speed of different type of files read and write.

4.1.3 CPU pt.

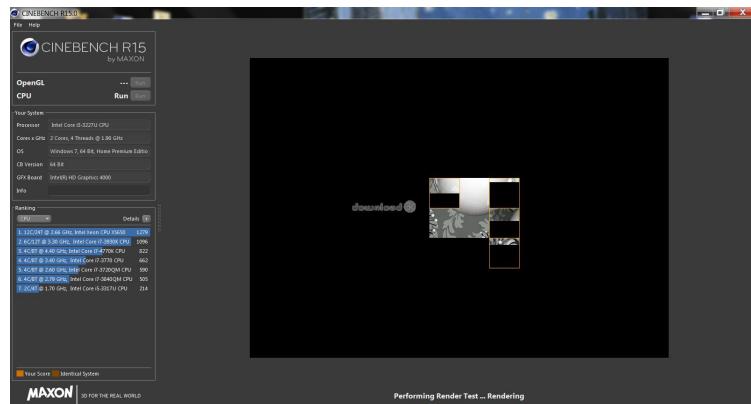


CPU-Z: Software that can display various hardware information and test CPU scores.

4.1.4 GPU pt.

CineBench is a professional cross platform test suite, which is used to evaluate the hardware functions of computers. Based on the Cinem4D engine, it can test the processor subsystem, memory subsystem and display subsystem at the same time. It is

powerful and can help users test their own computer CPU more accurately.



In the figure, the CPU is performing Cinebench image rendering test.

4.1.5 Endurance test.

In this testing session, I borrowed a first-line brand gaming laptop from my friend Zack zhang and did control variables test with my Windows phone.

Test content: normal web browsing, video playing, and Word document reading.

Test timing rule: unplug the power adapter after the system is fully charged until the device automatically shuts down

Test result: Laptop 2.22hours Windows phone 2.45hours

4.2 Conclusion of performance test.

See Chapter 5 :Conclusion of Performance

(Press and hold Ctrl key to realize fast jump)

4.3 User's experience

After all the performance tests, I asked some of my classmates and friends to use my Windows phone and put forward suggestions for improvement. These people have rich experience in using various electronic devices.

Some representative opinions are as follows:

1. The mobile phone will heat seriously during use, which may damage the life of the hardware. It is recommended to install a cooling fan.
2. The mobile phone is equipped with a bracket, which makes it easy to use the screen of the mobile phone without carrying an additional display screen, and can

support the mobile phone to make the body fully contact with the air, so as to accelerate the heat removal of the body in the form of thermal convection.

3. In the movie Chinatown Detective 2, female hacker KIKO used the projection keyboard as the keyboard of her laptop, which not only improves the portability to the extreme, but also makes the Windows phone look very cool when used.



From the movie clip of Chinatown detective 2

4.3.1 Secondary design after user experience upgrade

After collecting these valuable suggestions, I immediately have consideration and made changes to my design:

1. Add magnetic mobile phone cooling fan.

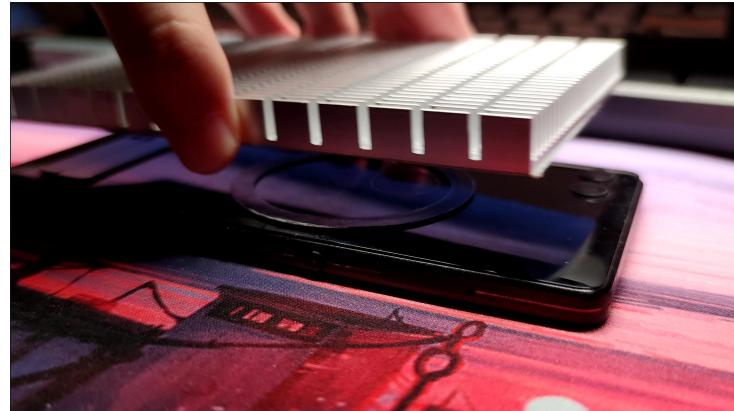


Semiconductor cooling fan in operation

For normal Android phones, the system usually sets a temperature wall to reduce the frequency of the core computing unit when the system detects that the hardware temperature reaches a certain threshold, thereby reducing the temperature protection hardware. However, for Windows phones, no one has ever made temperature control for phones with almost no

cooling system, so the heat generation will be uncontrollable after a long time of use, and it is really necessary to install cooling devices.

But, the scheme of using active cooling fan also has a defect, that is, there is noise during operation. So on this basis, I have made an alternative solution for users to choose freely: passive cooling fins.



Use metal fins to increase the contact area with the air, and use heat convection and heat conduction to naturally dissipate heat.

2. Holder



Portable mobile phone holder

3. VR²¹ Box

A variety of operation modes and display modes make me suddenly curious, so I thought that maybe using VR boxes can also get a good experience without using portable screens.

²¹ VR: Virtual Reality.



Windows phone in VR box

The advantage of this display mode is that it has a strong sense of immersion and can get the best experience when watching videos

Chapter 5: Conclusion and Evaluation

5.1 Conclusion of Performance

In the terms of performance, compared with traditional PC²² hardware (See attachment table), the above scores for CPU and GPU are enough to complete daily use, that is, the use needs selected by most people in the questionnaire section, such as online classes, making PPT, Word documents, watching online videos.....

As far as the performance of the hard disk is concerned, hundreds of megabytes of data per second can be read and written to ensure that the system will not get stuck during normal operation and that the user's system can be used smoothly.

However, at this stage, Windows phones cannot release the same performance as PC due to the limitation of body size, and video editing software or 3D modeling software that requires high performance cannot be guaranteed to run smoothly just like most thin and light laptops .

On the other hand, although the battery life of mobile phones has little advantage over laptops, for a Windows phone, its CPU architecture is ARM rather than x86. This means that my device has an energy consumption ratio unmatched by traditional computers. For a game laptop, the power consumption of about 150W is common, but

²² PC: Personal Computer.

for the host of my device, the power consumption is only 18W.

The advantage brought by this is not only to save electricity, but also to improve the portability in daily use. For a laptop with 100W+power consumption, you may need to carry a power adapter with a weight of more than 1KG. Because of the limitation of charging power of the power pack, most of the power packs cannot provide high-power power supply with a weight of more than 100W. For a mobile phone with only 18W power consumption, the battery life of the phone actually depends on how much capacity you want to carry. And this can bring even dozens of times of improvement in endurance.

5.2 Project Evaluation

For Windows phone, it is not only a handheld computer, but also can be used normally as a mobile phone. Take a Windows phone with you when you go out to meet most of your needs for electronic devices. Windows phones can meet most of your needs for electronic devices, whether you are making PPT with a computer or switching back to the Android system to answer calls with a mobile phone or order takeout.

With the update and iteration of electronic products, you will find that the consumer electronic products used by people are always getting smaller and smaller, and the mobility and portability are constantly expanding and enhancing. In a word, portable electronic products are indispensable in today's production activities and learning. In the network era, we cannot guarantee that we can work and learn in a fixed place. I think that perhaps one day in the future, Windows phone will be able to replace laptops or tablets to some extent because of its excellent scalability, portability and modular design concept.

5.3 Limitation

The number of reference to strong academic nature literature is rarely in this report.I think the reason for this is that the professionals in the professional fields involved in

this paper are of low age and educational background. Most of the project team members of Renegade Project are high school students. They lack the will and demand to write their valuable academic achievements into formal academic documents. While other geek players' answers in CSDN are non academic but highly professional, they also lack the appeal and willingness to write formal academic literature.

5.4 Last Words

In a word, my project uses a low budget to provide users with a solution that they can actually operate, not necessarily a product, at the same time, the second-hand mobile phones and portable screens that are redundant in the market or idle at home have new uses and meet the needs of the students and office workers for the windows software ecology.

Finally, at the end of the EPQ project, I reviewed the goals set at the beginning. I not only met the needs of people for mobile office learning, but also ensured the low price of Windows phones and strong expansion capabilities.

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