



DECONSTRUCTING A LENOVO THINKPAD SL500:
A Reverse Engineering Analysis

GEARSQUAD #21549A

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SUMMARY REPORT

The device we chose to reverse engineer was a Lenovo ThinkPad SL500. This laptop was released in 2008, a time where some of our team members were not even born! This made us wonder what technology was 'cutting edge' at that time compared to what it is now. Whilst uncovering this technology of the past, one of our primary objectives was to learn about differences in the specifications and capabilities of the different parts of the laptop, compared to something we might expect to see in a modern laptop. We answered this question by successfully analysing different components, such as the hard drive, which has significantly evolved since 2008. By discovering differences in the components of this laptop and what we would expect to find in a modern one, we get to the core of what makes this 'old' technology different.

Laptops are a work of art: the flow of electricity gives life to it, like the blood in our body. In this sense, the lithium-ion battery which we removed first was the heart of the computer. The way every component worked with each other was reminiscent of a human body; components like organs that co-ordinate with each other and producing the result of a fully functional laptop.

Upon uncovering the motherboard, we saw a plethora of components we couldn't identify, such as the 116 initially mysterious-looking resistors, which is where our in-depth research was relied upon to fill in the gaps of our knowledge. We thoroughly enjoyed discovering the unknown and learning about components and systems we previously had no idea about. We concluded that the way this laptop worked was very precise and well-orchestrated, although it would seem quite basic when compared to ones we all own today.

We encountered several challenges when it came to research and taking the laptop apart. To overcome these issues, we applied our logic and existing knowledge of computers. Whilst we had identified some components with ease, we struggled to label others, so considered what role the component played in the laptop, and what other functions would be necessary in its circuit. The research we conducted supplemented our pre-existing knowledge and aided to extend our understanding to far greater degree than we envisioned when we started this project.

Reverse engineering brought us together as a team, as we strategized the best way to go about research, we solved problems together while figuring out how exactly we should take the laptop apart, and how precisely we would present our findings. We thoroughly enjoyed learning about software and hardware development in the process, discovering how the machines we use every day work and how they have evolved from technology regarded as "old" now. This project made us appreciate technology, and the genius and hard work applied to create something as complex as this. Moreover, reverse engineering did not only teach us about technology and what makes laptops so special, but we learnt resilience and strengthened our teamwork, skills we will cherish later in life.

Word count: 500 Words



INTRODUCTION TO THE LAPTOP

The product we reverse engineered was the Lenovo SL500, Product ID 2746CT0



Figure 1.1 Front view with lid open



Figure 1.2 Left view



Figure 1.4 Right view



Figure 1.3 Top view (lid closed)



Figure 1.5 Front view (lid closed)



Figure 1.6 Bottom view



Figure 1.7 Back view

THE DISASSEMBLY PROCESS



Figure 2.1 Safety Goggles

Safety

Wear safety goggles while disassembling the laptop, to ensure everyone's safety.

Also ensure the laptop isn't connected to a power source before disassembling.

Tools

To disassemble the laptop, we needed a cross-slot screwdriver.



Figure 2.2 Other necessary tools required for opening the laptop



Figure 2.2 Cross-slot screwdriver

Step 1 – Remove the battery

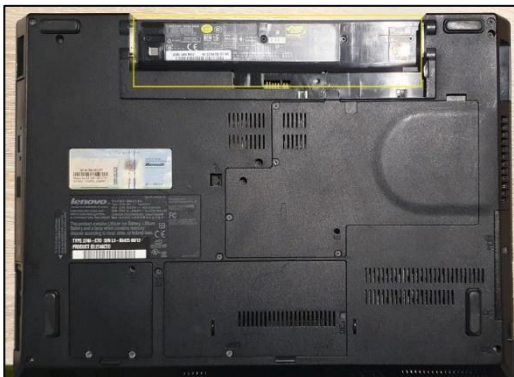


Figure 3.1 Location of battery boxed in yellow



Figure 3.2 The lithium-ion battery

Step 2 – Remove the hard drive

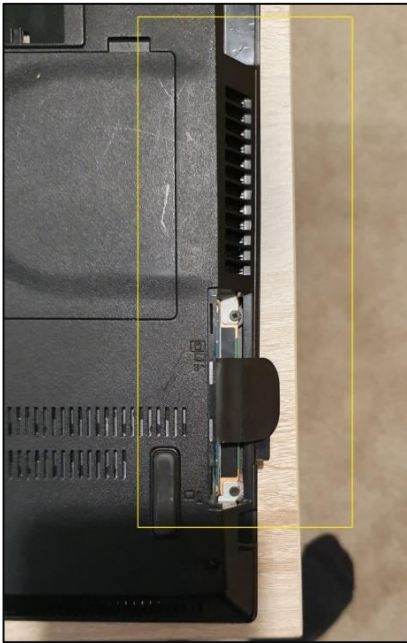


Figure 4.1 Location of hard drive



Figure 4.2 Opening the hard drive slot



Figure 4.3 Metal case covering hard drive



Figure 4.4 Back view of hard drive



Figure 4.5 Metal case



Figure 4.6 Hard drive with metal case removed

Step 3 – Remove first cover of motherboard

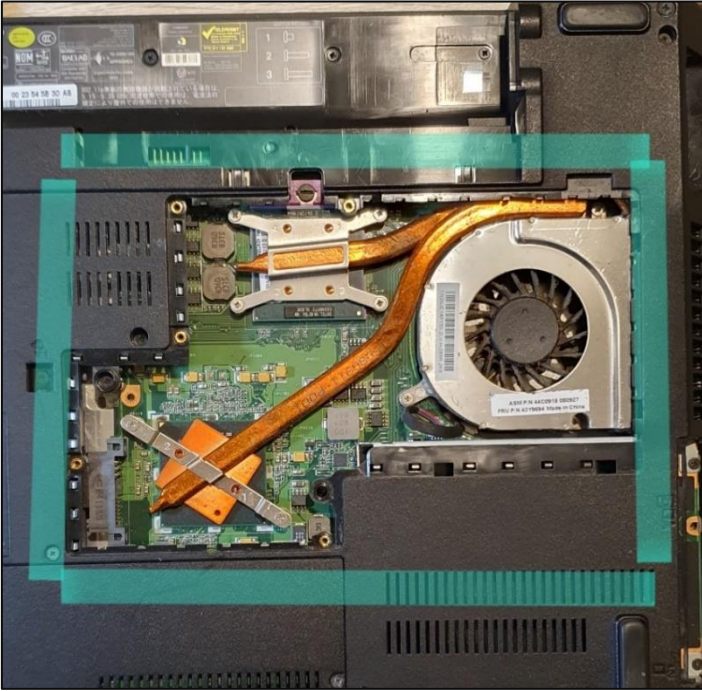


Figure 5.1 First area of the motherboard to

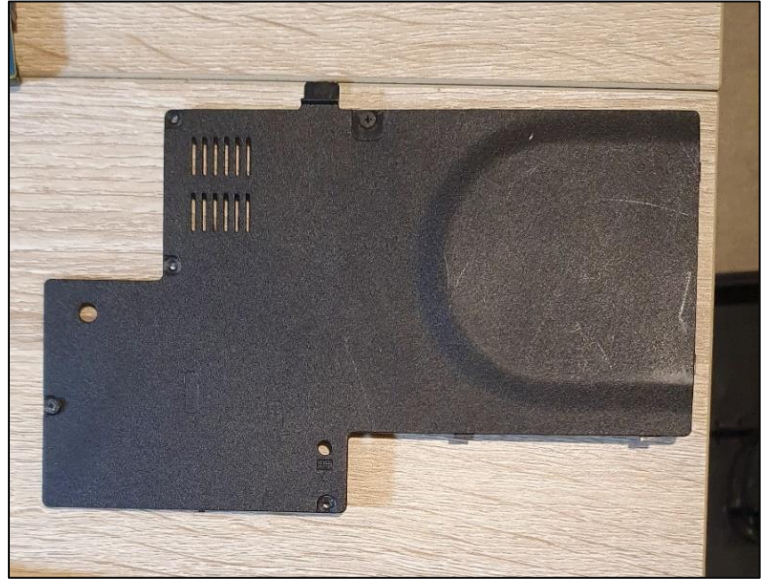


Figure 5.2 Cover for motherboard

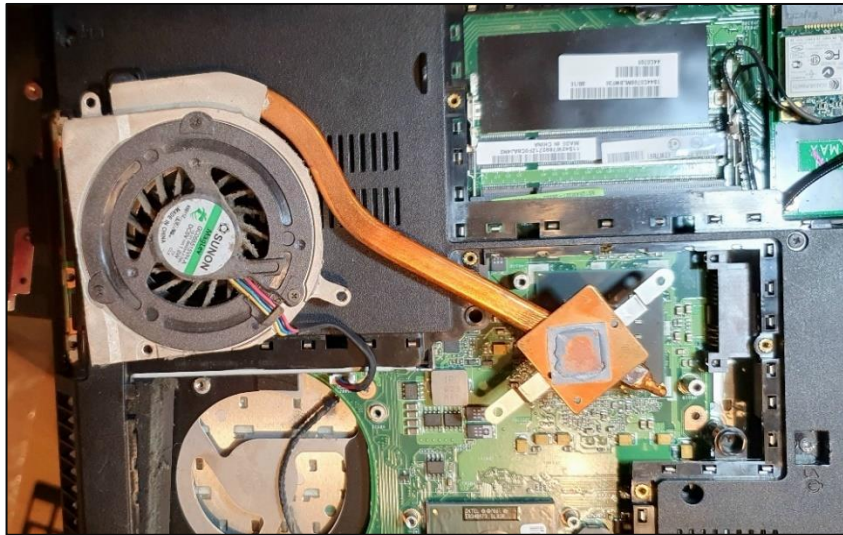


Figure 5.3 Removal of the fan and heatsink

Step 4 – Remove second cover of the motherboard

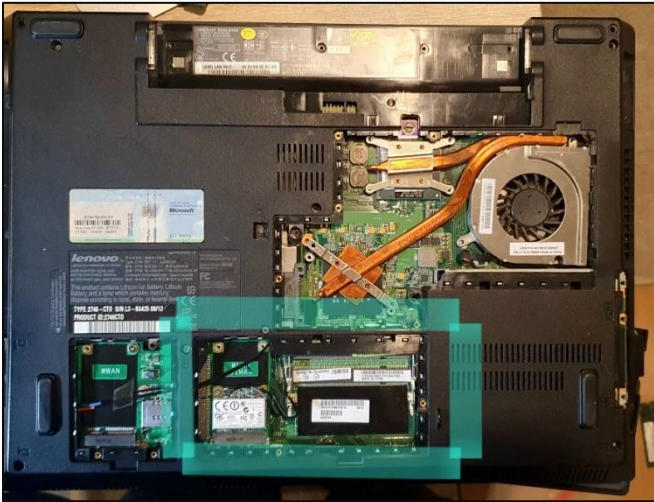


Figure 6.1 Second area of motherboard to inspect.

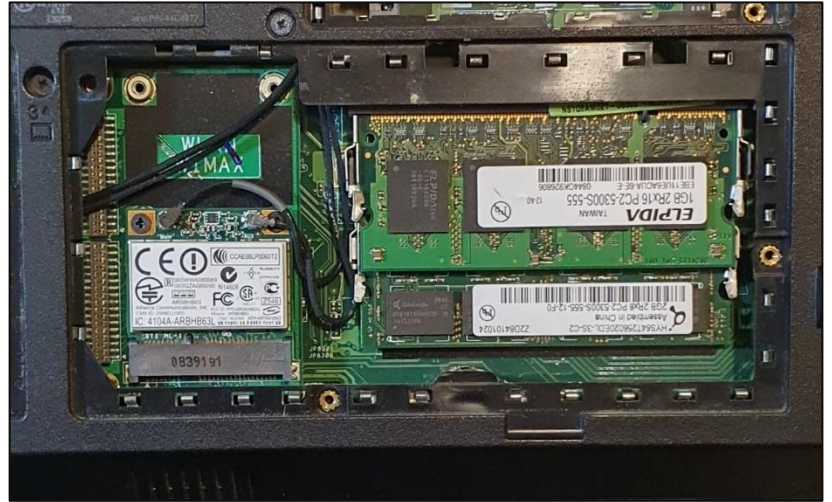


Figure 6.2 A zoomed in view

Step 5 – Remove third cover of the motherboard



Figures 7.1 and 7.2. Third area to inspect with a zoomed in view



Step 6 – Open the disc drive



Figure 8.1 Disc drive opened

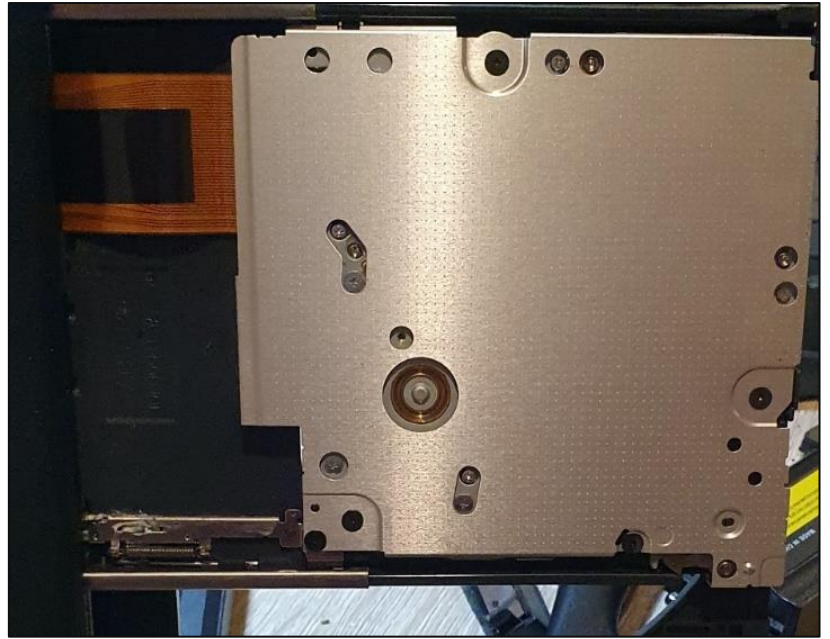


Figure 8.2 Back view of disc drive

Step 7 – Open the final cover of the motherboard



Figure 9.1 Final area of motherboard to inspect

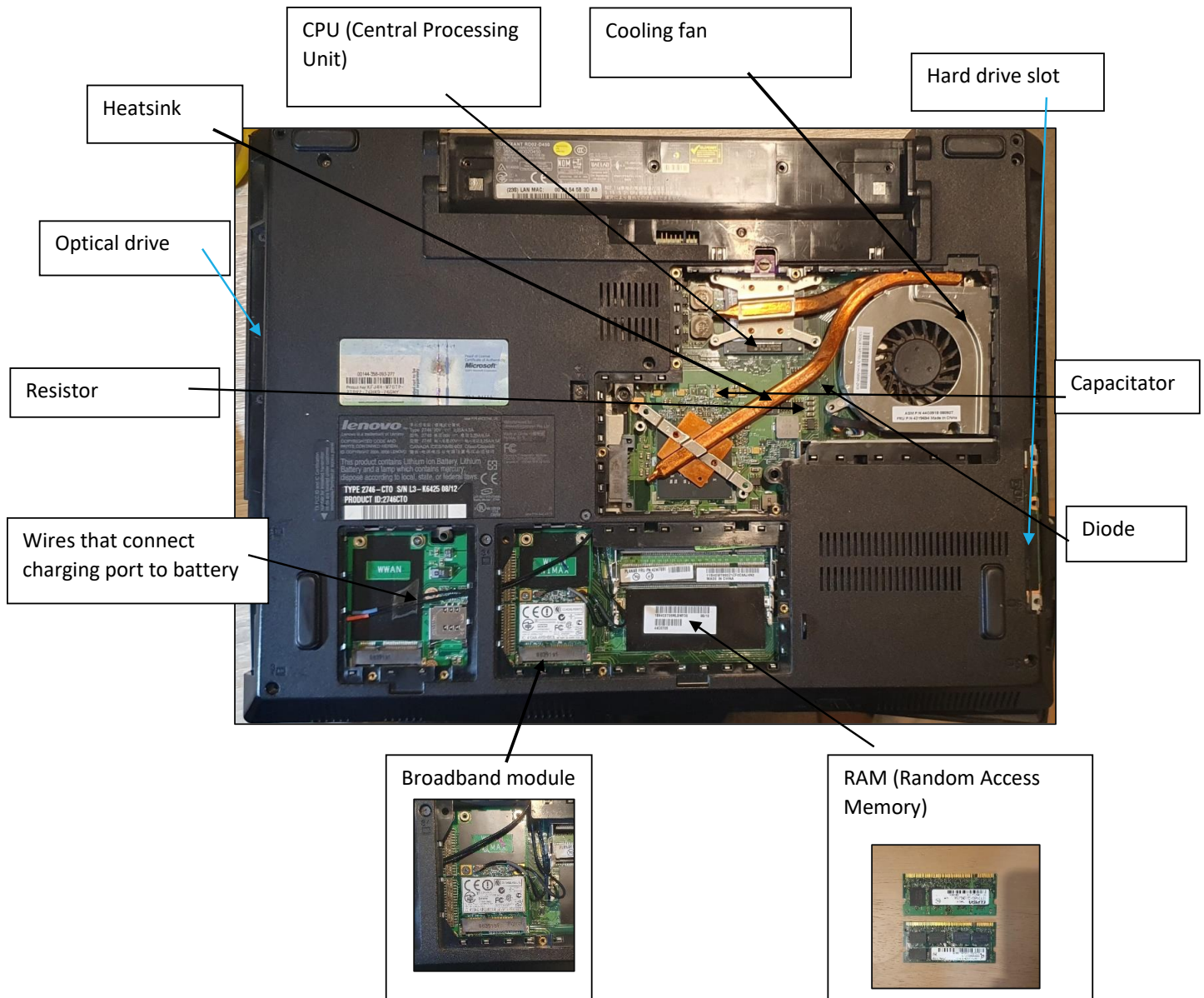


Figure 9.2 Zoomed in view

ANALYSIS

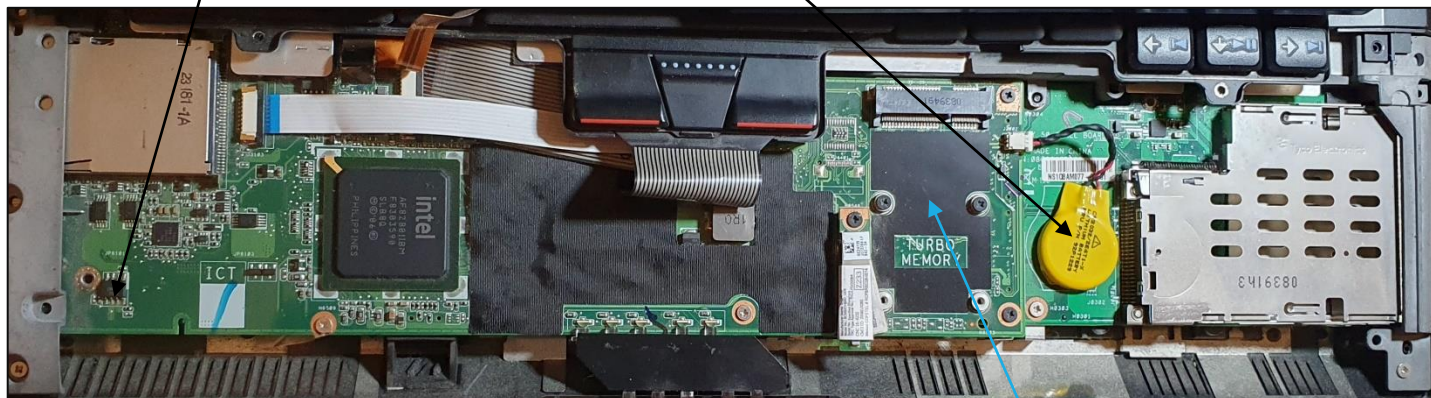
To successfully identify the components, present in the computer, we had to do research to learn what they each looked like, and what their role in the machine was.

Motherboard Annotated



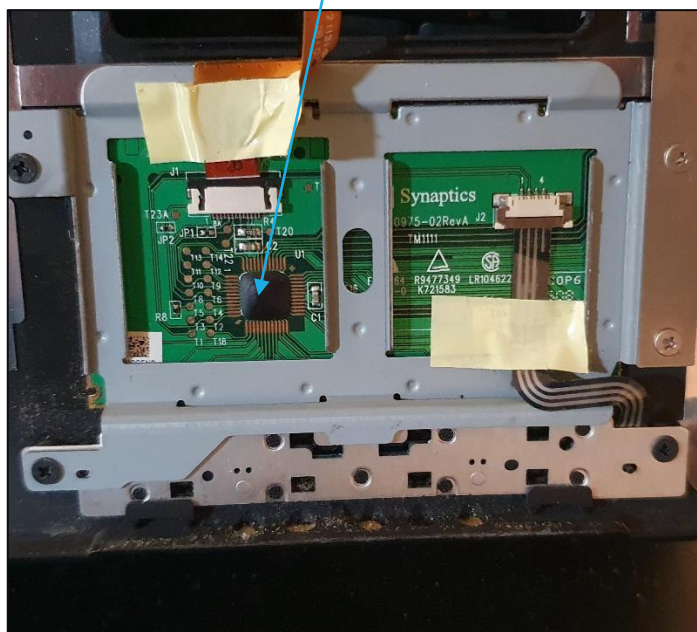
Integrated circuit

RTC Battery



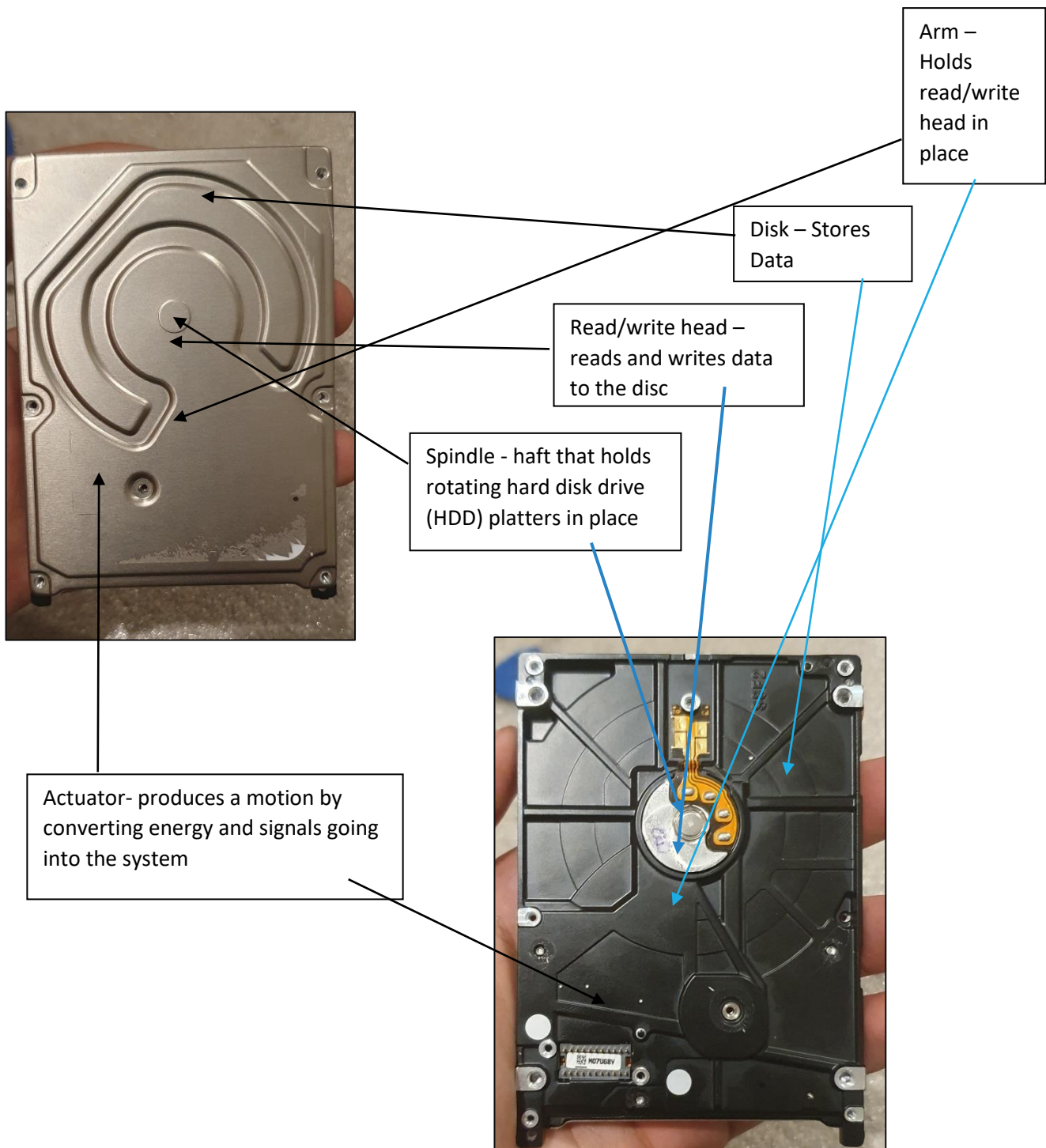
Chip connected to touch sensor MX Chip

Flash memory



HARD DRIVE ANALYSIS

Unfortunately, as we did not have all the tools to completely reverse engineer the hard drive, and see all its inner workings, we have annotated what we would expect to see under the final sheet of metal (which we could not remove), based on research.



We based our annotations from this image we found whilst doing research:

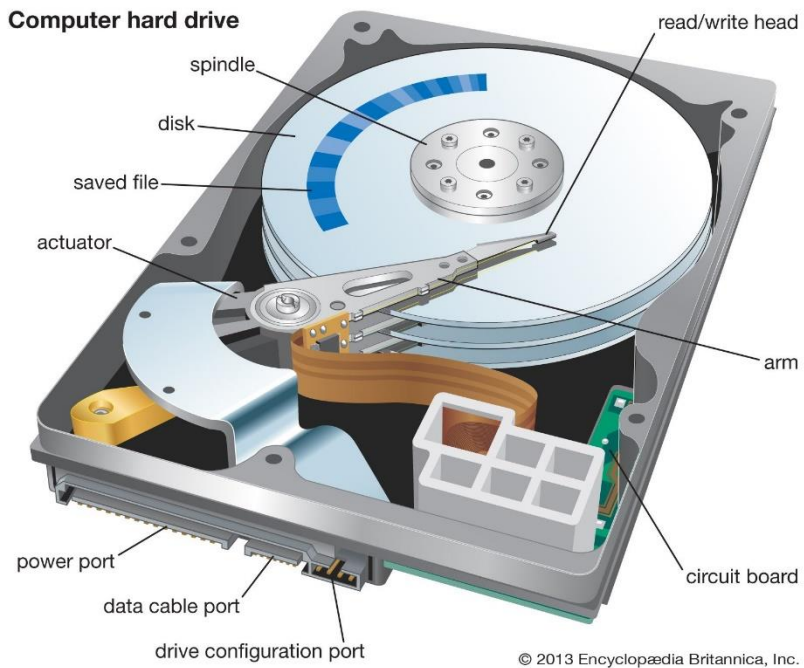





Figure 10.1 Source: <https://www.britannica.com/technology/hard-disk>


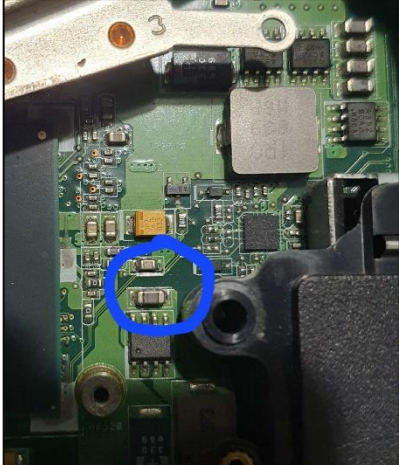




Resistor

Integrated circuit

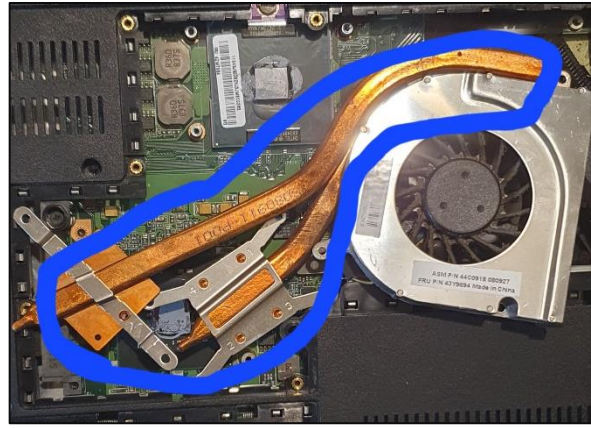
COMPLETE PARTS LIST

Name of part	Function	Image
CPU (Central Processing Unit) X1	Houses the circuitry required to process input commands and output. It constantly executes programs that tell the computer what data to store, and in which order. It is like the 'brain' of the computer.	
Hard drive X1	This is a non-volatile data storage device. It holds data even when the computer is turned off.	
RAM (Random Access Memory) X2	This is a volatile data storage device. It only stores data while the laptop is on.	

<p>Optical drive X1</p>	<p>A computer system that can read CDs, DVDs, or even data on discs.</p>	
<p>Resistor X116</p>	<p>An electrical component that creates resistance in the current.</p>	
<p>Capacitor X14</p>	<p>A device that stores electrical energy.</p>	
<p>Cooling fan X1</p>	<p>This cools the components, such as the CPU, so they do not overheat.</p>	

Heatsink
X1

Uses conduction to draw heat away from the CPU.



Diode
X5

A component that allows the current to pass through one way, but restricts flow from the other direction.



RTC Battery
X1

Real Time Clock. Provides power for the laptops' calendar.



Broadband module
X1

Used to send and receive
data over Wi-Fi.



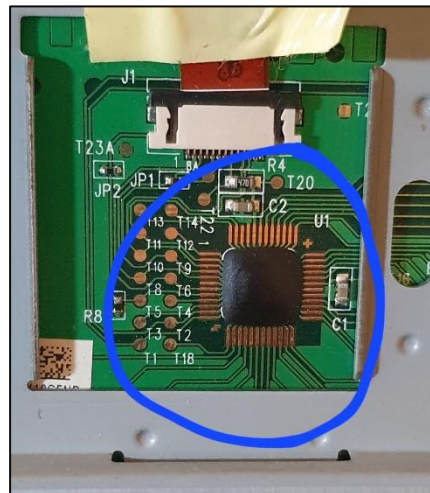
Integrated circuit
X11

A circuit that houses
millions of tiny diodes and
other components.



MX Chip
X1

A microcontroller which
houses many different
sensors.



Flash Memory
X1

A store of data that can be electrically wiped and reprogrammed.



QUANTITY OF PARTS/COMPONENTS ON THE MOTHERBOARD

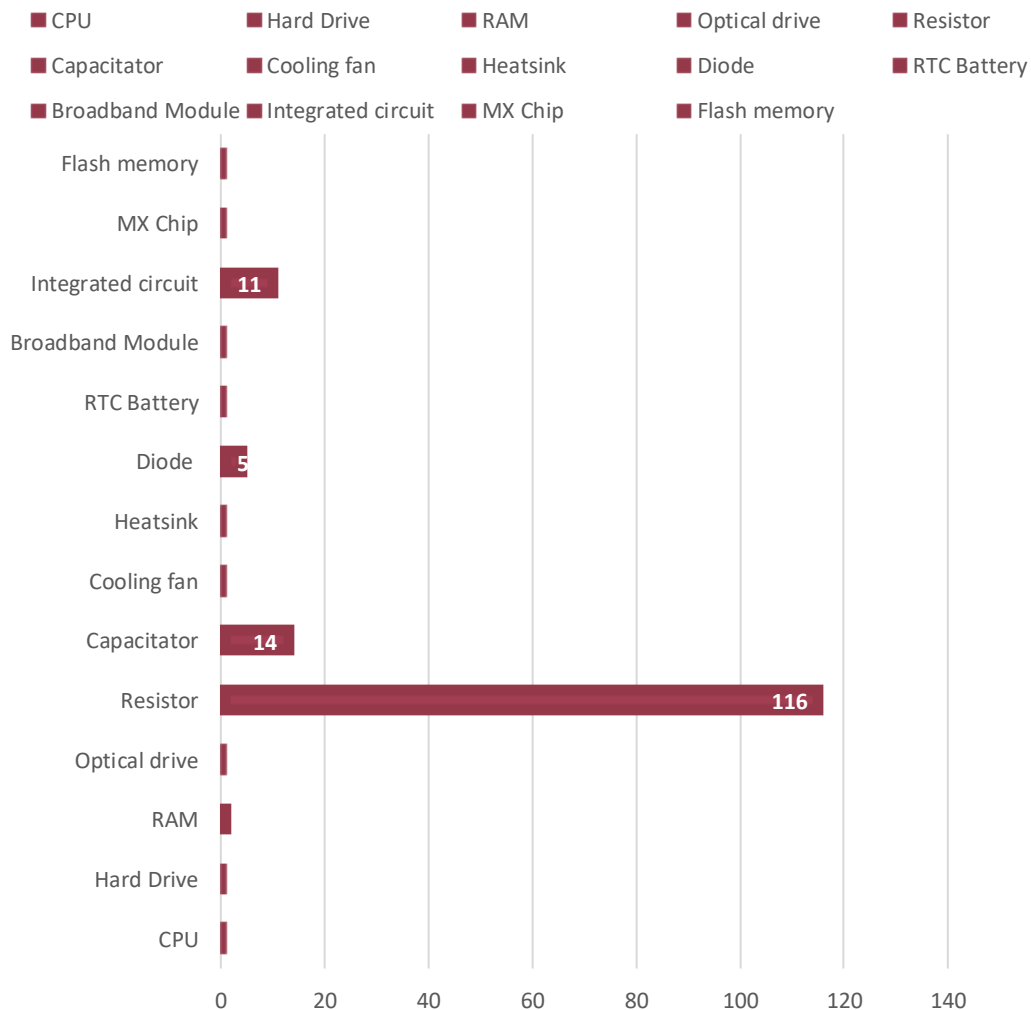


Figure 11.1 Bar chart showing the distribution of parts

Quantity of circuit components on the motherboard

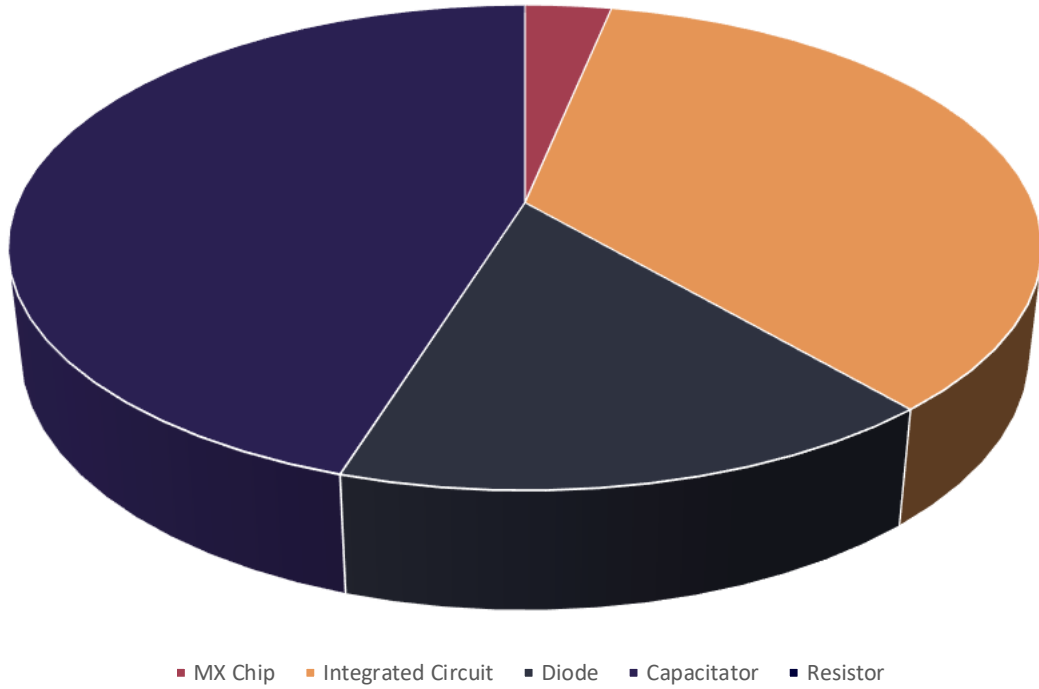


Figure 11.2 Pie chart showing distribution of electric components

EVOLUTION OF TECHNOLOGY

We wanted to deep-dive into certain aspects of the parts of the laptop that had changed dramatically. The laptop we inspected used a Hard Disc Drive. In laptops today, we would instead see a Solid-State Drive.

Here are the differences between the 2 types of hard drives.

SSD	vs	HDD	
faster	✓	✗	slower
shorter lifespan	✗	✓	longer lifespan
more expensive	✗	✓	cheaper
non-mechanical (flash)	✓	✗	mechanical (moving parts)
shock-resistant	✓	✗	fragile
best for storing operating systems, gaming apps, and frequently used files			best for storing extra data, such as movies, photos, and documents

Our laptop also used an Intel 2 Duo CPU, which is slower than most processors today.

We also noticed that the bottom of the laptop had very visible screws, while modern laptops keep their screws concealed, or harder to find, possibly to seem more user-friendly.

Aside from this, we also learnt that laptops evolved by becoming more compact as the development of CPUs made this possible. By having stronger processors, the weight and size of other components was able to shrink, leading to the modern, compact laptops we have today.

BIBLIOGRAPHY

1. <https://www.britannica.com/technology/hard-disk>
2. [https://www.thefreedictionary.com/Capacitor#:~:text=\(k%C9%99%2Dp%C4%83s%E2%80%B%C4%AD%2D,Also%20called%20condenser.](https://www.thefreedictionary.com/Capacitor#:~:text=(k%C9%99%2Dp%C4%83s%E2%80%B%C4%AD%2D,Also%20called%20condenser.)
3. <https://en.wikipedia.org/wiki/Capacitor>
4. <https://www.idtech.com/blog/parts-of-a-computer>
5. <https://www.fluke.com/en-gb/learn/blog/electrical/what-is-a-diode#:~:text=A%20diode%20is%20a%20semiconductor,flowing%20in%20the%20opposite%20direction.>
6. https://en.wikipedia.org/wiki/Integrated_circuit
7. <https://learn.sparkfun.com/tutorials/resistors/all>
8. <https://www.businessinsider.com/guides/tech/what-is-a-trackpad?r=US&IR=T>
9. <https://athomecomputer.co.uk/inside-a-computer/#:~:text=Inside%20a%20computer%2C%20there%20are,don't%20have%20a%20computer.>
10. https://www.youtube.com/watch?v=HB4I2CgkcCo&ab_channel=GCFLearnFree.org
11. <https://www.nisshinbo-microdevices.co.jp/en/faq/063.html>
12. <https://www.dell.com/support/kbdoc/en-uk/000146231/intel-turbo-memory>
13. https://en.wikipedia.org/wiki/Flash_memory
14. <https://www.fierceelectronics.com/electronics/what-a-chip-inductor#:~:text=Chip%20inductors%20are%20thin%20wire,available%20in%20%E2%80%9Cchip%E2%80%9D%20ofom.>
15. <https://www.lairdconnect.com/wireless-modules/bluetooth-modules>
16. <https://learn.microsoft.com/en-us/dynamics365/field-service/cfs-iotcentral-mxchip>
17. <https://www.hubspire.com/what-is-a-cpu-and-what-is-its-function/>
18. https://en.wikipedia.org/wiki/Random-access_memory
19. <https://www.digitaltrends.com/computing/what-is-ram/>
20. https://en.wikipedia.org/wiki/Optical_disc_drive
21. <https://eepower.com/resistor-guide/resistor-fundamentals/what-is-a-resistor/#>
22. <https://www.pinterest.co.uk/pin/718816790506059582/>
23. <https://electronics.howstuffworks.com/capacitor.htm>
24. <https://www.notebookcheck.net/Lenovo-Thinkpad-SL500.11157.0.html>
25. https://erc-bpgc.github.io/handbook/electronics/Modules/wifi_module/#:~:text=Wifi%20modules%20or%20wifi%20microcontrollers,field%20of%20Internet%20of%20Thnigs.
26. https://en.wikipedia.org/wiki/Intel_Core_2
27. <https://www.avast.com/c-ssd-vs-hdd>
28. <https://www.guidingtech.com/61156/evolution-modern-laptop/>
29. https://www.reac-group.com/en_en/facts/actuators/what-is-an-actuator/#:~:text=An%20actuator%20is%20a%20device,signals%20going%20into%20the%20system.
30. <https://www.techtarget.com/searchstorage/definition/spindle#:~:text=A%20spindle%20is%20a%20shaft,to%20gauge%20disk%20drive%20performance.>
31. <https://www.techopedia.com/definition/9112/readwrite-head#:~:text=A%20read%2Fwrite%20head%20is,attached%20to%20an%20actuator%20arm.>
32. <https://www.techtarget.com/searchstorage/definition/hard-disk-drive#:~:text=They%20can%20store%20operating%20systems,storage%20device%20in%20a%20computer.>

33. <https://www.bhphotovideo.com/explora/computers/tips-and-solutions/anatomy-hard-drive#:~:text=Arm%20%2D%20This%20holds%20the%20heads,seeking%20a%20track%20or%20sector.>