What's Inside

The Samsung Galaxy S4?

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1.0 – WHY THE S4?

The product we decided to reverse engineer is the Samsung Galaxy S4. It was the perfect product as it was the flagship product of Samsung in 2013, currently the world's leading phone manufacturer. This hardware did wonders for its time, and we wanted to discover the potential of older technology and how much technology has progressed over time.

Unfortunately, the phone had reached the end of its life, but we wanted to figure out the issue. To satisfy our curiosity we reversed engineered the phone and understood its components. The S4 was also one of the last phones with a removable cover which made the easy-to-repair model a reality, however, since then companies have decided to add a screwed back cover which cannot be removed easily.

Specs: 5-inch display with a 1920 x 1080 resolution. 2 GB RAM, and a 13 and 2-megapixel rear and front camera respectively

FIGURE 1 – FRONT AND BACK VIEW OF THE S4

2.0 – PROCESS

Samsung Galaxy S4

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Product Analysis

Safety Precautions i.e
batteries and wearing
safety goggles

History Of Device

Research

How to take apart the
device?

Component List

↓

Disassembly

↓

Identification of
Components

↓

Take Pictures when
making progress of the
reverse engineering

↓

Documentation

Research → Analysis / Conclusion

Components
Researched → Function Of
Component

FIGURE 2 - FLOWCHART SHOWING THE PROCESS AND STEPS WE WILL FOLLOW FOR THIS PROJECT

3.0 – ARCHITECTURE DIAGRAM

An architecture diagram will show how different components in this smartphone interact with one another. We used this tool to understand the components of the phone.
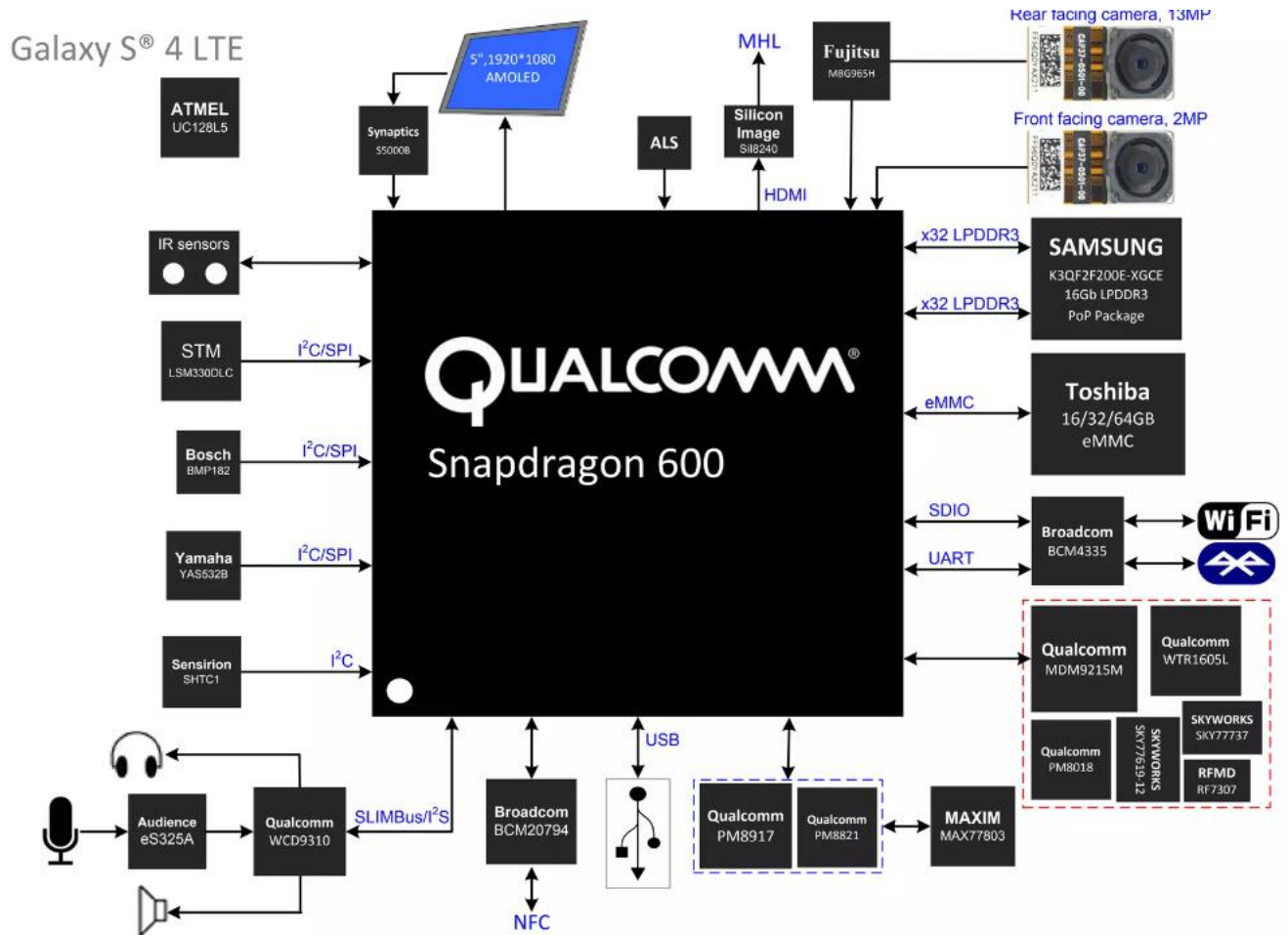
FIGURE 3 – ARCHITECTURE DIAGRAM OF A SMARTPHONE

4.0 – Teardown Process

26ᵗʰ December 2022 – HK, YS, RR, TN

Aim Of Today: Conduct research on the most efficient method of dissembling the S4, then begin the teardown of the product.

⚠️ Wear Safety Equipment such as safety gloves and goggles to prevent any injury.

After conducting research, we first had to:

- Remove the back cover.
- Heat the screen of the phone to *melt the adhesive applied.*
- Use picks on the side to ply open the device.

Step 1 – Remove the Back Cover of the phone. This can be done without the assistance of any tools. Then remove the battery to prevent any shocks.

Figure 4 – A Galaxy S4 with the back cover removed
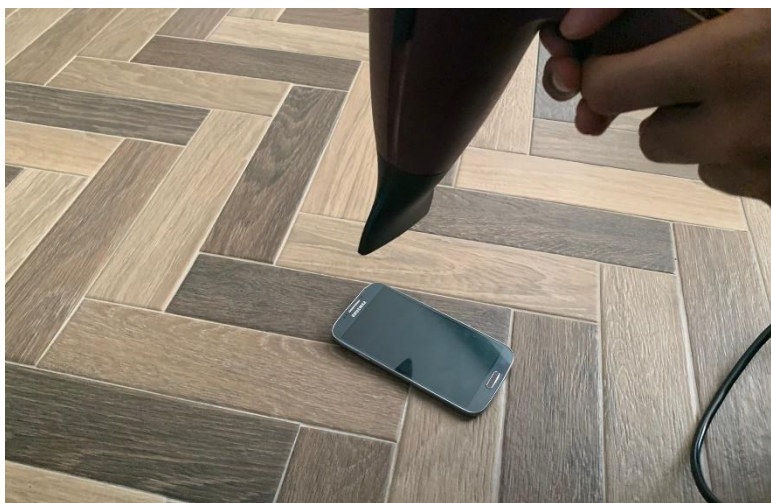
Step 2 – Heat up the front screen of the phone.

⚠️ The screen will get hot to touch. Proceed with caution

Figure 5 – Using a Hairdryer to melt the adhesive

Step 3 – Use Guitar Picks to ensure the screen does not stick again.

FIGURE 6 – GUITAR PICKS UNDER A GALAXY S4'S SCREEN

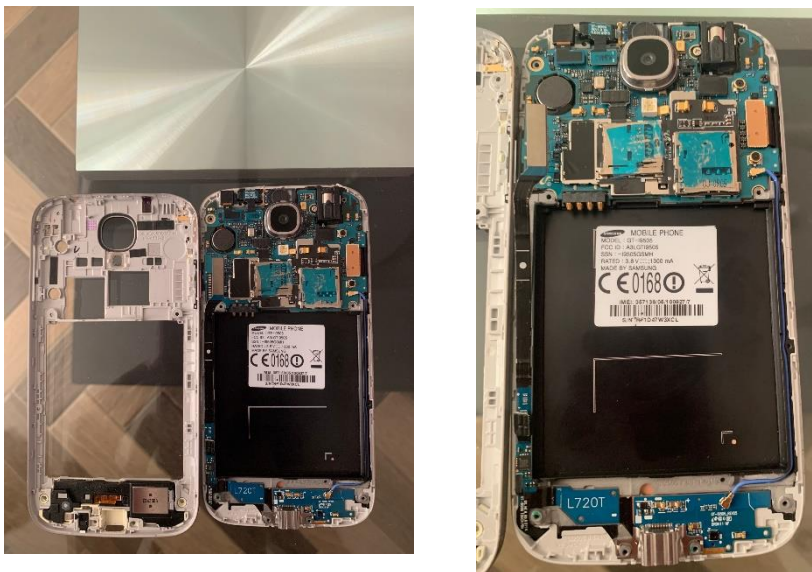**Step 4** – Lift the screen off when enough adhesive has been removed.

FIGURE 7 – THE 'INNARDS' OF THE S4

TIMELINE - DAY 2

27th December 2022 – HK, YS, RR, TN

Aim Of Today: Continue teardown and identify all the components.

Step 5 – Disconnect everything on the motherboard to get individual parts.

FIGURE 8 – THE 'MAIN' STRUCTURAL COMPONENTS

5.0 – COMPONENTS ANALYSIS

5.1 – Schematics and Blueprints
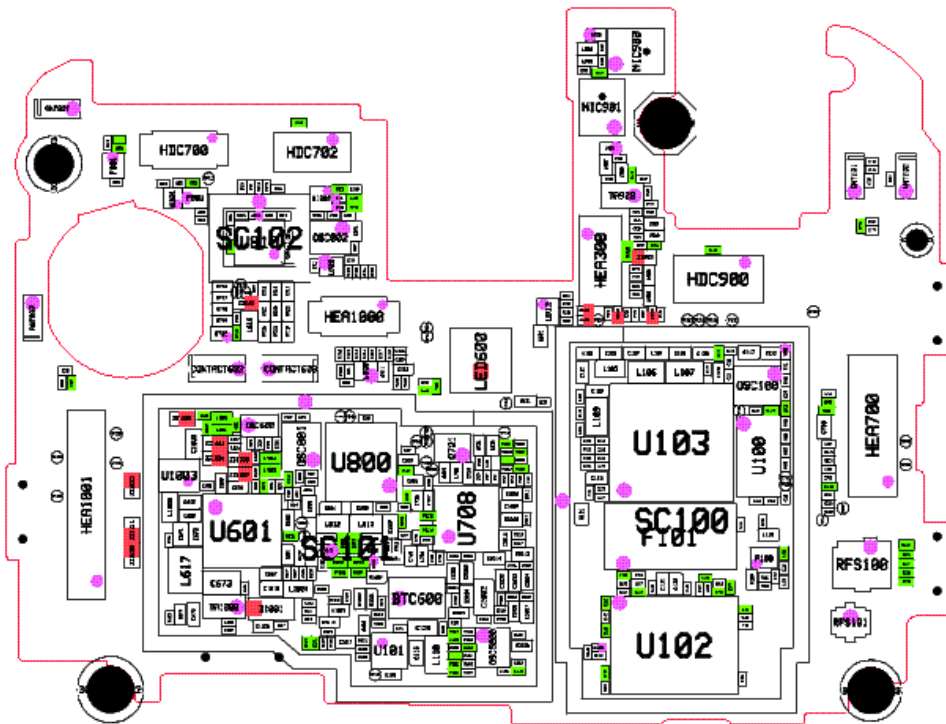
FIGURE 9 – SCHEMATICS OF THE GALAXY S4
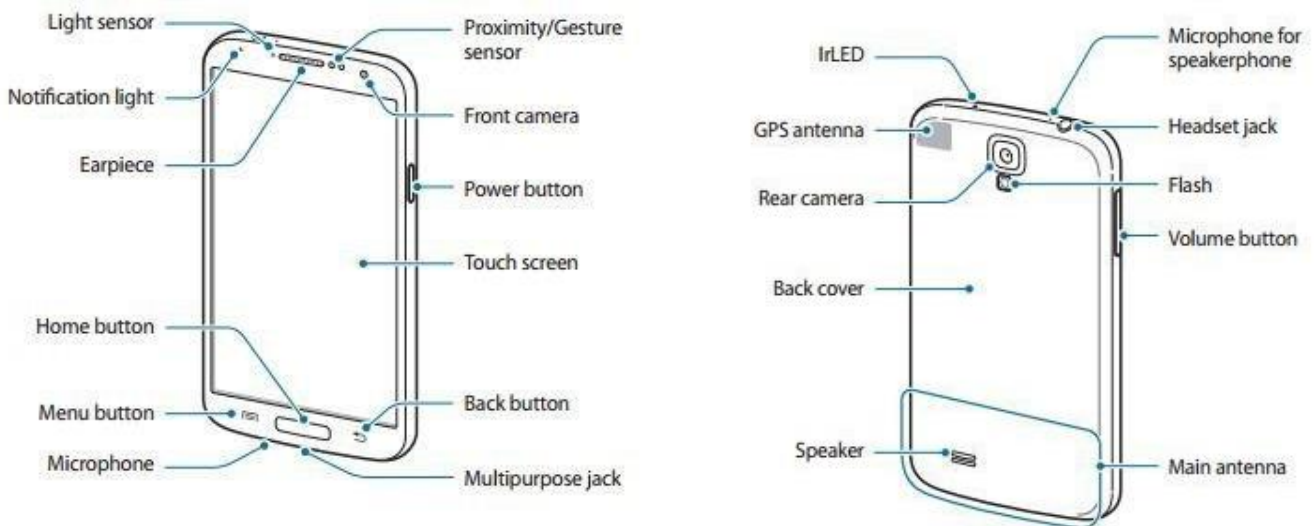
FIGURE 10 – LABELLED BLUEPRINT OF THE SAMSUNG GALAXY S4

5.1.1 – Motherboard - Labelled Images of the circuit board (front)

Broadcom BCM4335 Single-Chip 5G Wi-Fi MAC/Baseband/Radio

Qualcomm PM8917 Power Management

ARM Holdings MBG965H

Qualcomm MDM9215M 4G GSM/UMTS/LTE modem

Samsung K3QF2F200E 2GB LPDDR3 RAM

Qualcomm WCD9310 audio codec

Toshiba THGBM5G7A4JB A4W 16 GB eMMC

Bosch Sensortec BMP180 barometric pressure

FIGURE 11– LABELLED CIRCUIT BOARD (FRONT)

5.1.2 – Labelled Images of the motherboard (back)

Maxim MAX77803 Microcontroller

Broadcom 20794S1A standalone NFC chip

Silicon Image 8240BO MHL 2.0 transmitter

Qualcomm WTR1605L seven-band 4G LTE chip

Skyworks 77619 power amplifier module for quad-band

SWA GNF09
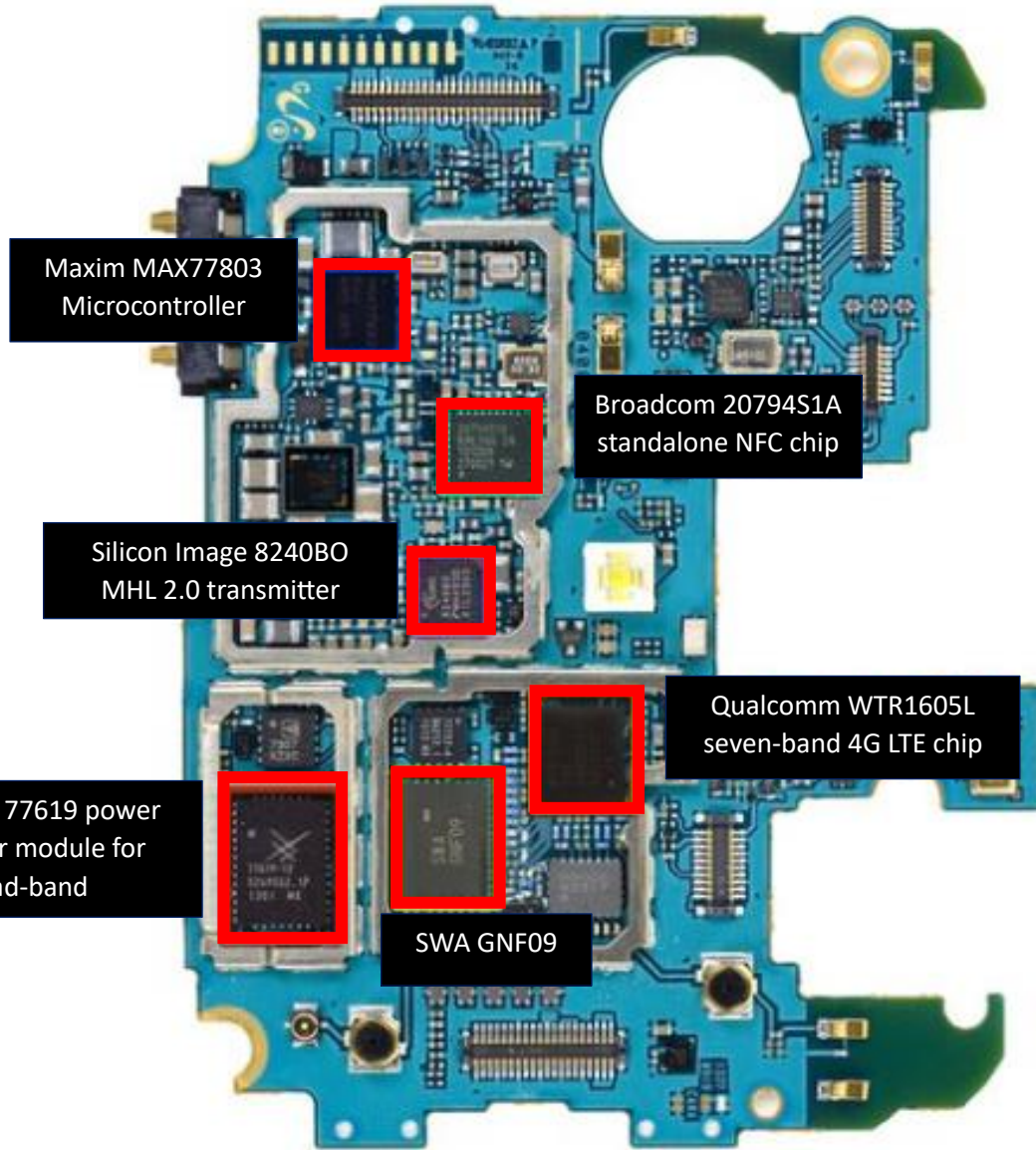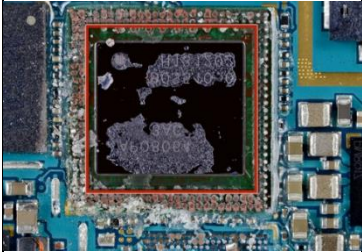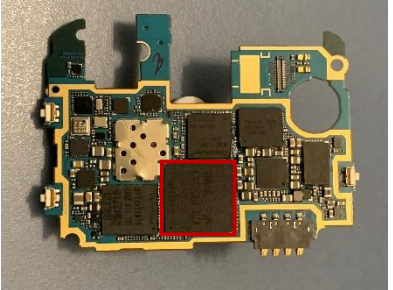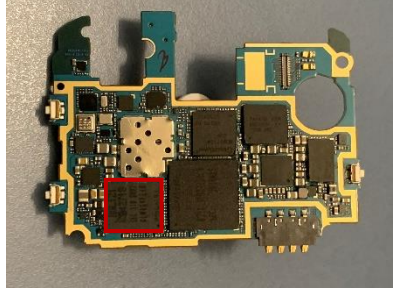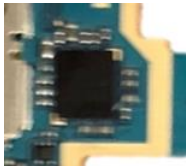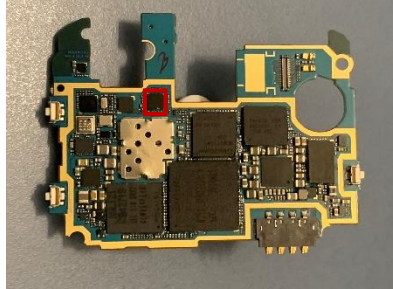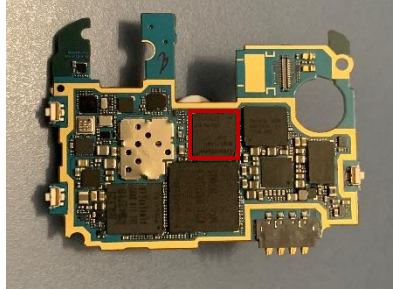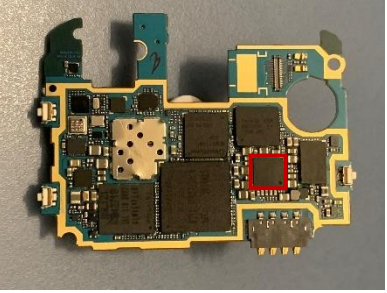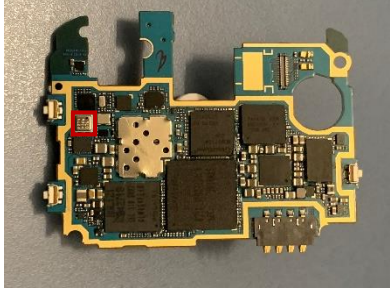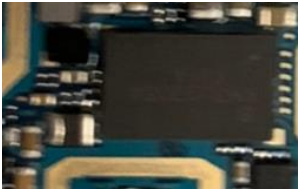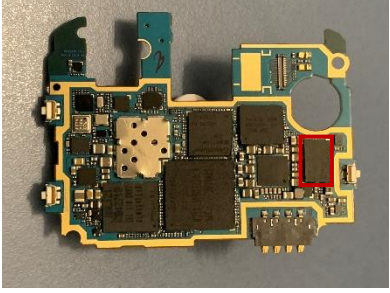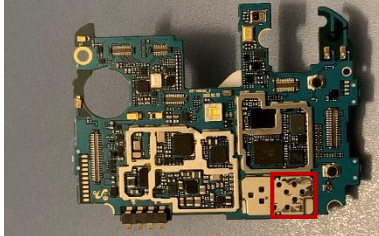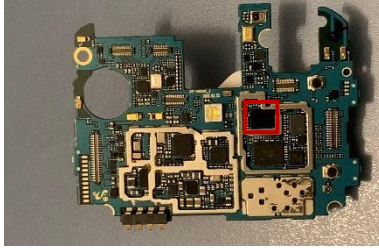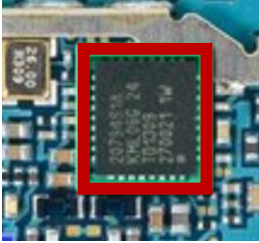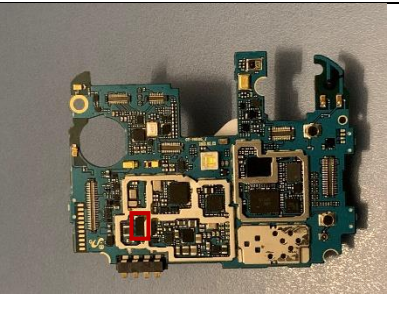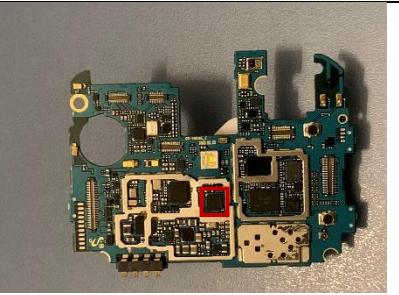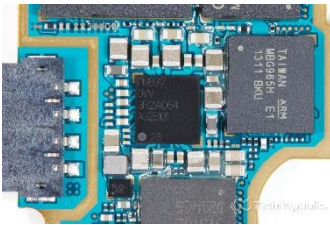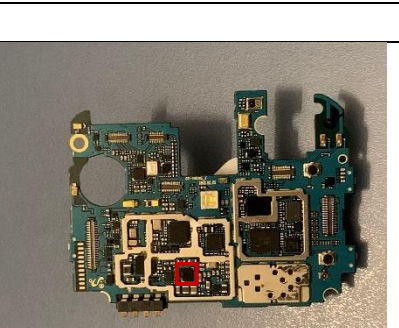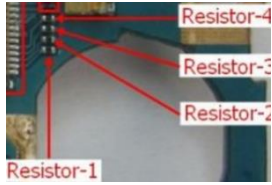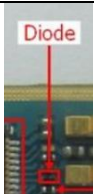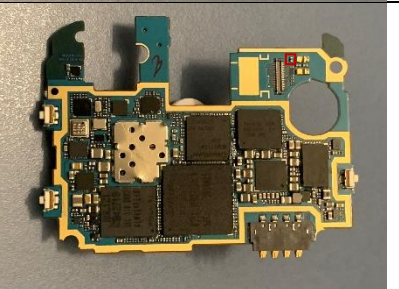
FIGURE 12– LABELLED CIRCUIT BOARD (BACK)

Part and Description	Image	Location
Snapdragon 600 APQ8064T 1.9 GHz Quad-Core CPU. This is the Central Processing Unit also known as the processor. This is the 'brains' of the device and executes instructions. The CPU can perform controlling, logic, and basic arithmetic, input/output operations. This is the most important component of the device. **Data Sheet:** https://www.qualcomm.com/content/dam/qcomm-martech/dmassets/documents/snapdragon_600_apq_8064_data_sheet.pdf		
Toshiba THGBM5G7A4JBA4W 16 GB eMMC An embedded MultiMediaCard (eMMC) is a storage device and its made up of NAND flash memory. It acts as the primary storage for the phone. Now phones use SSD instead of eMMC as it faster and more efficient		
Qualcomm WCD9310 audio codec An audio codec is the component that encodes analog audio as digital signals and decodes it back into analog. **Data Sheet:** https://www.datasheets.com/en/part-details/wcd9310-qualcomm-99304847#risk		
Qualcomm MDM9215M 4G GSM/UMTS/LTE modem Modems in a phone are made to modulate analog signals like telephone signals which are transmitted using cellular networks. This allows the device to get online.		

Qualcomm PM8917 Power Management The power management system includes the storing, generation and distribution of regulated voltages to different components in the mobile system		
Bosch Sensortec BMP180 barometric pressure sensor This component measures the resulting pressure difference when the device experiences a change in elevation. **Data Sheet:** https://cdn-shop.adafruit.com/datasheets/BST-BMP180-DS000-09.pdf		
Broadcom BCM4335 Single-Chip 5G Wi-Fi MAC/Baseband/Radio This component integrates several things into one. A single-stream 5G WiFi system, Bluetooth 4.0, FM Radio and software all on a single silicon die		
Skyworks 77619 power amplifier module for quad-band GSM/EDGE A Power amplifier increases the modulated Radio Frequency and signal and delivers it to the antenna.		
Qualcomm WTR1605L seven-band 4G LTE chip LTE is made to work across numerous frequency bands ranging from 450 MHz up to 3.8GHz		

Broadcom 20794S1A standalone NFC chip A Near-Field Communication chip is the component that enables short-range wireless communication between two devices		
Maxim MAX77803 microcontroller This is embedded inside a system which is designed to control a singular function of a device by receiving I/O peripherals		
Silicon Image 8240BO MHL 2.0 transmitter This dual-mode transmitted allows provides to integrate MHL technology into devices which enable a single SoC to support both HDMI and MHL technology without increasing the pin count.		
Qualcomm PM8821 power management IC This is used to manage power on devices or in modules that may have a range of voltages.		
Resistors A resistor limits or regulates the flow of electrical current in a circuit. They can also be used to provide a specific voltage for an active device such as a transistor.		
Diode A diode is a two-terminal electronic component that conducts current in one direction; it has low resistance on one side and high resistance on the other.		

6.0 – SUMMARY REPORT – LESSONS LEARNT

Throughout this project, we learnt how to reverse engineer a smartphone in a safe manner. Our team also learnt crucial skills on how to communicate and organise this project effectively. The smartphone always intrigued us, with such a small form factor it could carry out many different functions, and by taking this phone apart we have learnt how all the components in the phone function. Researching the architecture diagram helped us realise how each component communicates with one another. While documenting the phone, we learned the significance of perseverance and good research as we had difficulty finding the purposes of each component, which meant we had to skim through many different articles.

In conclusion, this project has taught us crucial skills outside of the competition field and will help us in our future dreams of becoming an engineer.

7.0 – CITATIONS

OTHER SOURCES SUCH AS DATA SHEETS ARE ON RELEVANT COMPONENTS IN 5.1.3

https://www.ifixit.com/Teardown/Samsung+Galaxy+S4+Teardown/13947

https://www.pinterest.com/pin/752734525199532474/

https://www.slideshare.net/jjwu6266/qualcomm-snapdragon-600-smartphone

https://www.mobile-manuals.com/samsung/galaxy-s-schematics/