

Unit 1: Mobile Devices

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1.1 LEARNING OBJECTIVE

To gain the knowledge regarding the mobile hardware architecture and hardware components of mobile such as processor, RAM, graphics, sensors etc.

1.2 INTRODUCTION

Mobile is a device which is made up by using different components like processor, RAM, graphic and different sensors. Mobile devices having the touch screen display which provides better user experience to provide the input. Now days mobile devices become the important part of human being in daily life to perform some task like phone calls, text SMS, reminders of important events and mathematical calculations etc. Mobile devices are capable to connect with internet and also capable to interconnect with each other by using the WIFI and Bluetooth.

1.3 MOBILE HARDWARE ARCHITECTURE

Mobile hardware architecture is the important part of mobile devices. Mobile device having the different hardware parts which are difficult to manage. We need to study the hardware architecture to understand the management of hardware by using the mobile operating system. Every latest smartphone used the System on Chip (SoC) Architecture. Following are the main components of the smartphone architecture.

- Application processor is used to execute the user's applications with the instructions from the middleware and the mobile operating system.
- A baseband processor with the own OS components performing radio transmission and reception of the audio, video and the data.
- Different peripherals for the user interface.

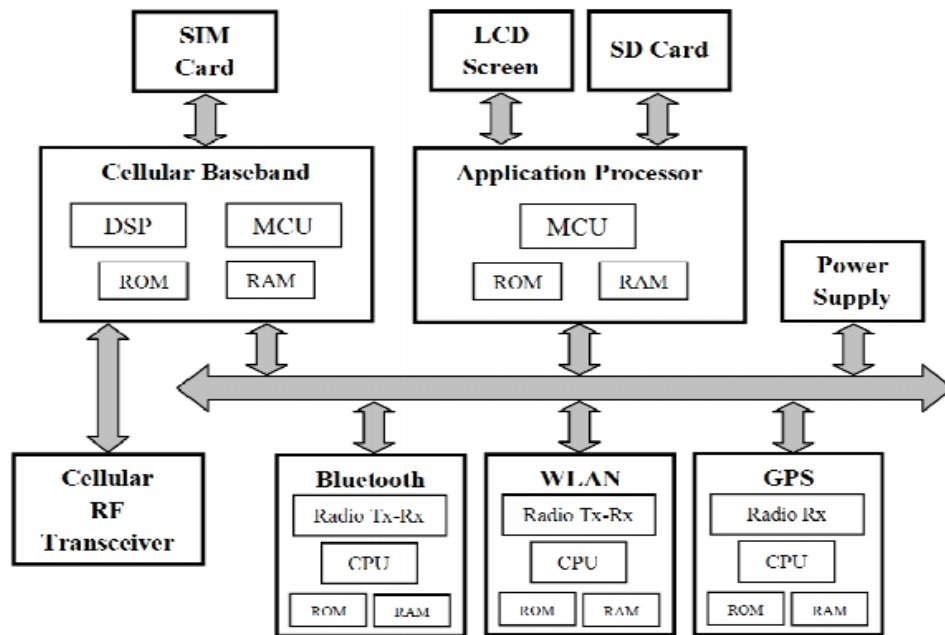


Figure-18 Mobile Hardware Architecture [1]

➤ **Receiver (RX)**

RX hardware component is the receiver of the incoming signals. After receiving the incoming signals, hand shaking is done with the physical layer. Later these signals are processed by the processor. The radio OS components hand shake with the peripheral to display the coming data to the user.

➤ **Transmission (TX)**

Device drivers support to write the data to the memory, from where they collected, for example audio from microphone, video from camera and location from the GPS sensor. After that data is processed by processor as per the transmission protocol. SIM (Subscriber Identifier module) plays an important role in data reception and transmission.

➤ **Application Execution**

The application processor executes mobile applications such as games, speech processing, internet browsing, image processing etc. latest smartphone have large volatile memory such as 1 GB, 2GB etc.

➤ **Typical ARM processor**

Processors which are used in mobile are quite different from those processors which are used in the laptop or in the computers. ARM processor

becomes the popular processor because of its capabilities like, optimization of battery life with good performance. Modern processor is separated by the ARM processor.

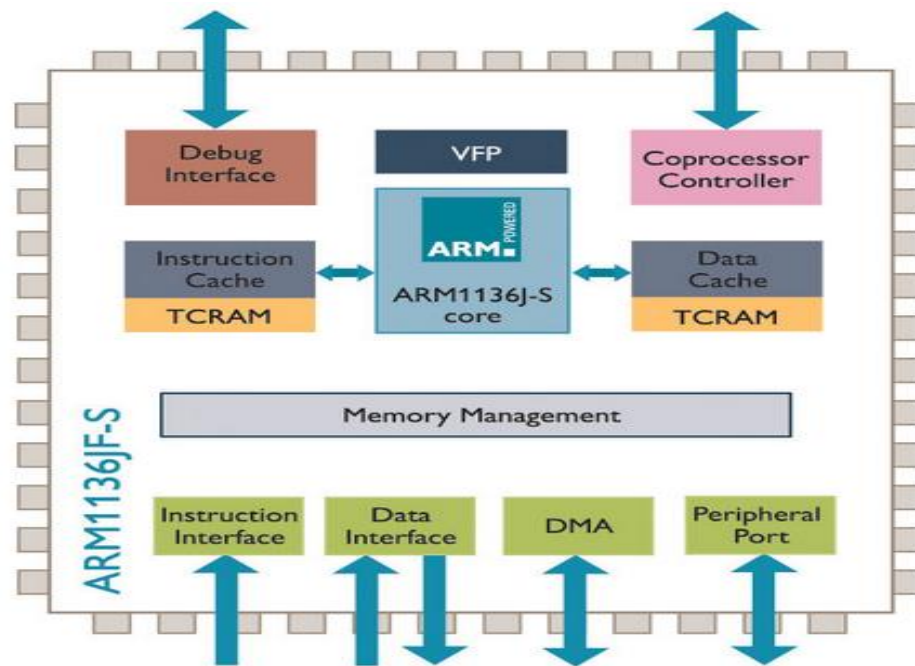


Figure-19 ARM Processor [1]

1.4 MOBILE HARDWARE DEVICES

Mobile is a smart device which is the combination of hardware and software. Mobile operating system is used to user interaction with mobile devices as well as used to manage the all hardware parts of the mobile devices such as processor, RAM, different sensors and different applications.

1.4.1 PROCESSOR

The processor is the central hub of any smartphone. Mobile processor is working like CPU (Central processing Unit) of the computer. Processor received command and it executes every command submitted by the user to perform different task with high accuracy and speed.

Processors which are used in mobile are quite different from those processors which are used in the laptop or in the computers. ARM processor becomes the popular processor because of its capabilities like, optimization of

battery life with good performance. Modem processor is separated by the ARM processor.

Latest smartphones are come with the multiple core processors like (2, 4 or even 8)



Figure-20 Available mobile Processors [2]

➤ **Qualcomm Snapdragon**

Qualcomm is the US Company which is developed the processor for smartphones. Qualcomm processor is used in all smartphones and tablets except Apple. Qualcomm is known of because Snapdragon its brand which is released the mobile processor as well as LTE modems.

➤ **Apple Mobile processor**

Apple does not make any processor instead they contract with processor manufacture company such as Samsung and TSMC for making custom processors for Apple phone.

➤ **Intel Atom**

Intel is American multinational company developed the processor for mobile as well as computers. Atom is the brand name identify for the low power consumption and low cost 32-bit and 64-bit processors for smartphone and tablets.

➤ **Nvidia Tegra**

Nvidia is the American company developed the processing units for the graphics, gaming units and mobile devices. Nvidia developed the chips for tablets and smartphone known as the Tegra brand.

➤ **MediaTek**

MediaTek is a Taiwanese semiconductor company providing chips for mobile devices, HDTVs and other electronic devices. MediaTek processor is working on the basis of 64 Bit ARM architecture. Clock speed of MediaTek processor is up to 3 GHz. They come in different cores such as Dual core, Quad core, Hexa core and Deca core.

➤ **HiSilicon**

HiSilicon is a Chinese company owned by the by Huawei. This company creates chip based processors working on the basis of ARM architecture. Processors are released by the HiSilicon such as K3V1, K3V2, K3V2E, Kirin 620, Kirin 650, Kirin 910 and Kirin 960.

➤ **Samsung Exynos**

Exynos is a brand of Samsung Electronics which makes processors based on ARM architecture. Samsung Exynos designed the series of processors such as Exynos 7 Dual, Exynos 7420, Exynos 7 Octa 7580, Exynos 7 Octa 7870.

1.4.2 GRAPHICS

The mobile GPU or graphics processing unit is used to accelerate the graphics applications such as 3D games, user interface and 3D contents on your mobile device. Photo realistic 3D games and live graphical user interface are examples to design the mobile GPU. GPU (Graphics processing Unit) is the central part of the hardware in the smartphones. GPU is handling the virtual elements of smartphone display while CPU handling the all heavy computations as well as the logical operations behind the screen. GPU and CPU are both the essential parts of the smartphone which directly deal with the device performance.

1.4.3 MEMORY AND STORAGES

Memory includes major components such as RAM and ROM.

➤ RAM (Random Access Memory)

RAM is the most important and critical part of the smartphone along with the processor and graphics. Without RAM the computing performance of smartphone become very poor. RAM is the working as the middle man between the file systems which are stored on to the ROM. Large and critical files are needed by the processor to store on to the RAM, waiting to the access.

RAM are used in the smartphone is technically D-RAM (Dynamic Random Access Memory). Contents of the D-RAM module is changed quickly and easily to store the different files. RAM is different from the ROM, if power is disconnected the data is lost from the RAM, it means RAM is the volatile (Temporary) storage. Speed of the smartphone is depends on the Ram. The clock speed is directly affects the input/output speed of the RAM.



Figure-21 of the iPhone 4S (Yellow Rectangle) [3]

Storage of smartphone is consisting by internal and external storage components.

➤ **Internal storage**

Like the RAM internal storage of the smartphone is the critical, without any place to store the OS and critical file smartphone is nothing to do. Depending on the operating system is loaded on to the device there are multiple storage chips in to the devices. File system is stored on to the chip is called as the ROM (Read only Memory).

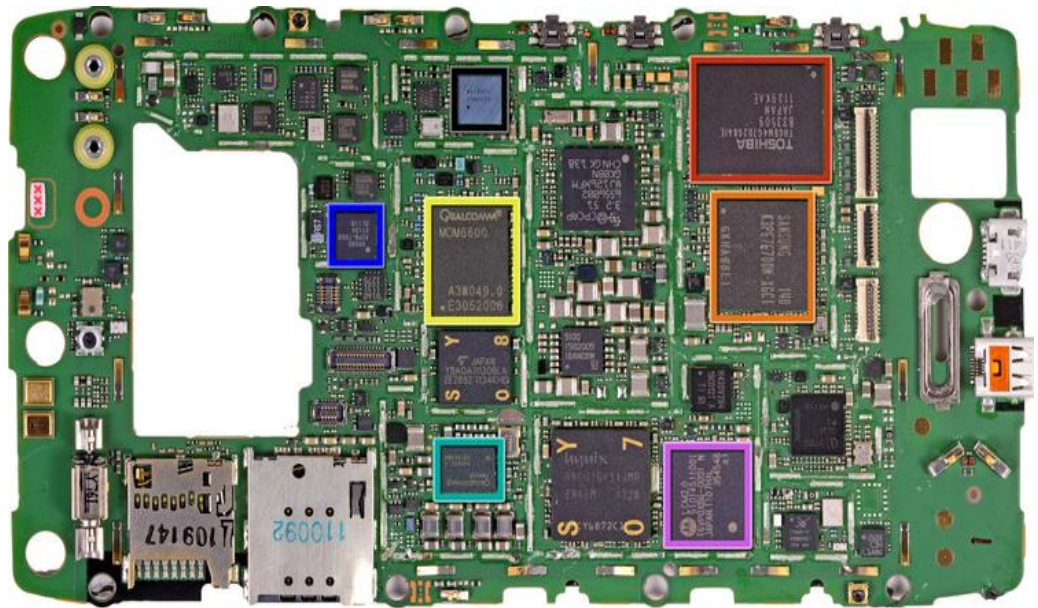


Figure-22 Internal Storage of Motorola Droid Razer (Red Rectangle) [3]

➤ **External storage**

User removal storage is called as the External storage due to the fact it can be removed by the user. Nowadays smartphone provides the facility to provide the external storage slot which is support to the microSD card.

Out of the different mobile operating systems such as iOS, Android and WP7, only Android mobile operating system supports to the removable storage. iOS devices which are developed by the Apple does not provide any facility to expand the external storage, instead they provide the internal storage which is used for the storing different applications, video and audio.

MicroSD card is available in three different sizes of the class. The original SD specification allows the size of the card up to 2 GB. SDHC

(SD high capacity) increased the size limit up to 32 GB. SDXC (SD Extended Capacity) increased the size limit up to the 2 TB.

Access speed of the external device is depend on to the Class of the MicroSD card such as class 4 written to at the minimum 4 MB/S, class 10 written to at the minimum 10 MB/S.

1.4.4 DISPLAYS

➤ TFT-LCD

TFT-LCD is called as the Thin Film Transistor Liquid Crystal Display. TFT-LCD display is used in the most budget smartphones. This display provides the higher resolution as compared to the previous LCD display. Disadvantage of TFT-LCD, This display provides the poor visibility in sunlight and it gives poor battery life for the large size display devices.



Figure-23 TFT-LCD display of SONY [4]

➤ IPS-LCD

IPS- LCD is called as the In-Placed Switching. IPS-LCD is superior as the TFT-LCD display. This display provides the wide viewing angles as well as the low power consumption. This display provides the better quality images as well as improved battery life.



Figure-24 IPS-LCD of Apple 4S [4]

➤ **Resistive touchscreen LCD**

Resistive touchscreen LCD is designed by the double layer of conductive material with small space left in between two layers. When screen is touched this two layers doing work together to complete the display circuit. This action sends command to the mobile operating system to perform the task.



Figure-25 Resistive touchscreen of Samsung [4]

➤ **Capacitive touchscreen LCD**

Capacitive touchscreen LCD is consist by single layer made by the transparent conductor (Indium Tin Oxide). When user touch to display the electrostatic field sends command to the mobile operating system to make the decision. Capacitive touchscreen display is more responsive which are providing the better user experience.



Figure-26 capacitive touchscreen of Samsung [4]

➤ **AMOLED**

AMOLED is called as Active Matrix Organic Light Emitting Diode. This display improved the quality and the performance of the device. This display provides the high level brightness and sharpness.



Figure-27 AMOLED display of Samsung [4]

1.4.5 CONNECTIVITY AND SENSORS

Different sensors are available for the smartphones such as Accelerometer, GPS, Gyroscope, Proximity, Magnetometer, Luxmeter and Microphone etc.

➤ **Accelerometer**

Accelerometer is used to measure the proper acceleration. Unit of accelerometer is m/s^2 or g . latest smartphones accelerometer provides the high precision values. Apple iPhone 4S provides the 0.018g precision.

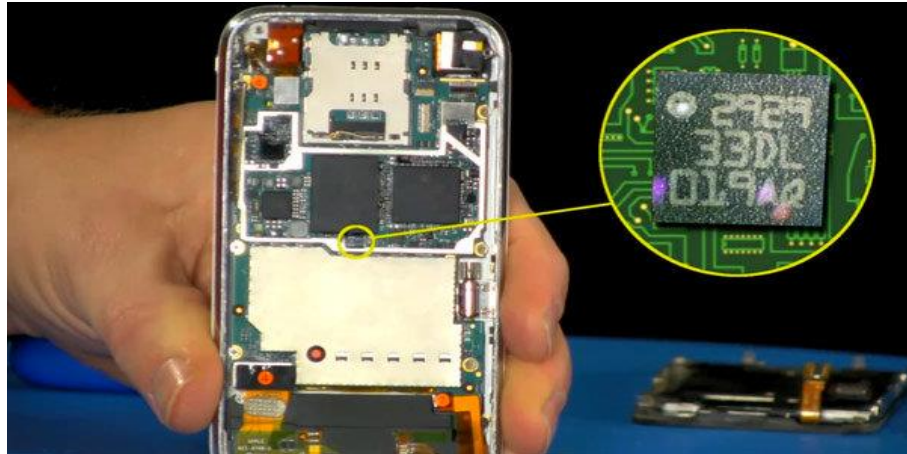


Figure-28 Accelerometer of smartphone [5]

➤ **GPS**

GPS sensor used to find out the location of the smartphone on to the google map. Connection with 3 satellites is required for fix latitude and longitude. Connectivity with more satellites is increase the precision of the position of the smartphone.



Figure-29 Position of device on to the map [6]

➤ **Gyroscope**

Gyroscope is used to find out the current orientation or changed orientation of the smartphone. Orientation is calculated with the help of the angular rate that is detected by the Gyroscope.

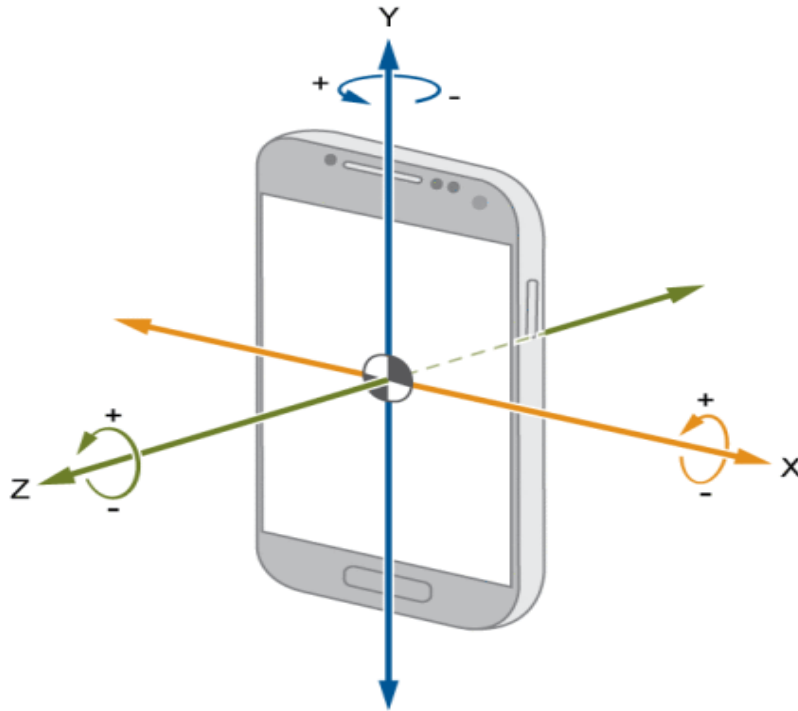


Figure-30 Gyroscope axis [7]

➤ **Magnetometer**

Magnetometer is used to find out the strength of the magnetic field. Strength of the magnetic field is measured in the tesla [T].

1.4.6 BATTERIES

Most common types of the smartphone batteries are listed below.

- Nickel-cadmium (NiCd)
- NiMH (NiMH)
- Lithium-ion (Li-ion)
- Lithium Polymer (Li-pol)

Latest smartphones are used the Lithium-ion battery. Lithium-ion battery is the packet of the extremely volatile chemicals and metals which are separated by the non-conductive, super thin layers which are prevents electrodes from the touching and triggering potential explosion reactions.



Figure-31 Lithium battery [8]

Lithium-ion is the common batteries for the portable devices with the high energy density.

A battery capacity is indicate, how much electricity provided to the device up to some time. For phones capacity is measured in mill ampere-hours (MAh). The larger capacity of battery provides the more electricity to smartphone up to the more time as compared to the smaller capacity battery. Proper charging of the mobile phone battery is useful to save the life of it.

- After completion of charging plug out the smartphone from the electricity network.
- Avoid the moisture on to the battery.
- Do not charge the battery if you bought from the freezing temperatures.
- Nickel-Cadmium and NiMH batteries must be charged only after full discharge while Lithium ion battery can charge regardless of the battery level.

1.4.7 CAMERAS

Camera is the one of the most important feature of the smartphone. Peoples want good camera quality of their phones to capture the quality images and videos. The front camera of smartphone is become important because of the trend of the selfies across the social network.

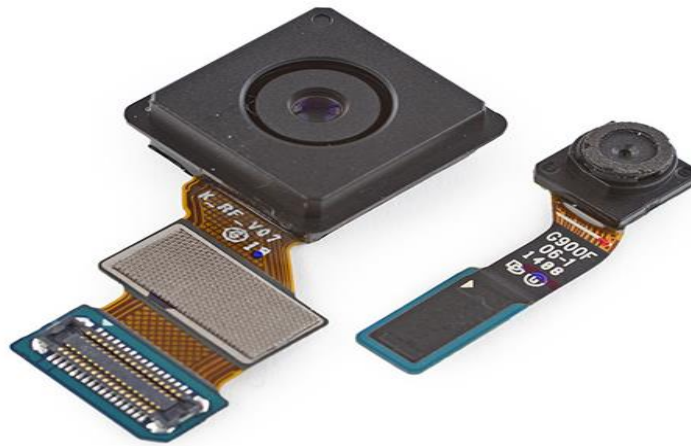


Figure-32 Camera of smartphone [9]

Smartphone camera module includes two main components such as the sensor and the lens. These two components are packed together and attached to the smartphone's main board using a ribbon cable. The sensor is the part of the camera used to capture images. The camera's circuits include photodetectors used to capture light, plus amplifiers and transistors. Smartphone cameras are built using CMOS (complementary metal-oxide-semiconductor) technology, which is a form of active pixel sensor.

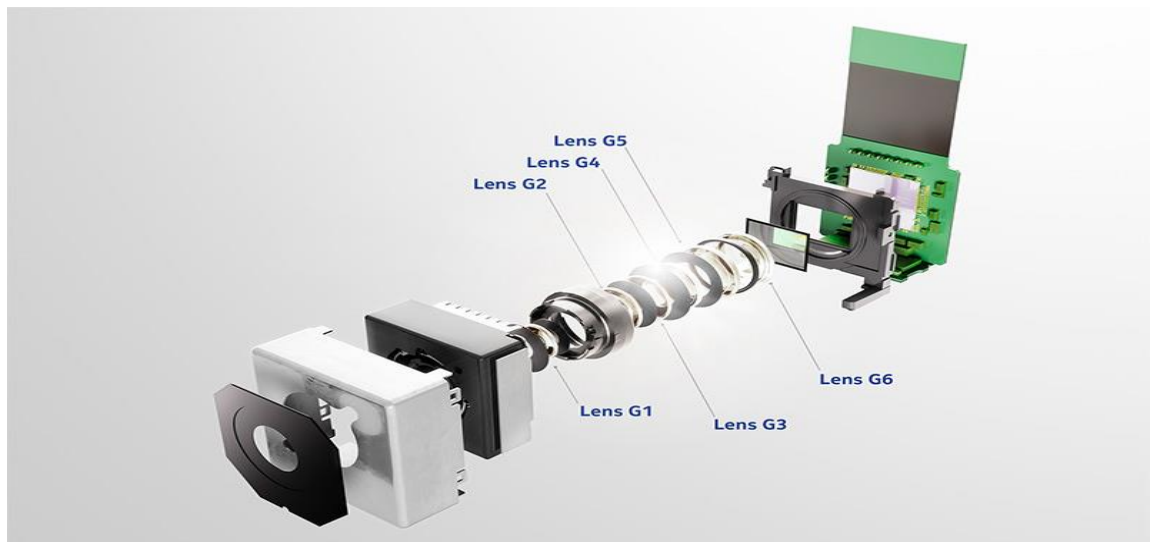


Figure-33 Construction of camera [9]

The lens is made up of multiple plastic or glass elements. With glass, it provides higher quality and sharpening. The lens elements work in conjunction with the small hole, which is before the sensor that the focused light travels through.

1.5 LET US SUM UP

Mobile devices are become the important part of human life. Every person use mobile device to make life easier. Mobile devices are used to voice call, text SMS, internet browsing etc. power management and hardware component management is difficult task in smartphones.

1.6 CHECK YOUR PROGRESS

1. Explain working of RX and TX in mobile hardware architecture?
2. What is mobile processor?
3. Explain the role of GPU in mobile devices?
4. Differentiate internal and external memory of smartphone?
5. Give the full form of RAM with its working principle?

1.7 CHECK YOUR PROGRESS: POSSIBLE ANSWERS

1. Refer 1.3
2. Refer 1.4.1
3. Refer 1.4.2
4. Refer 1.4.3
5. Refer 1.4.3

1.8 ASSIGNMENTS

1. What is GPS? Explain use of it?
2. Explain working of magnetometer?
3. Why use Gyroscope in smartphone?
4. Differentiate GPU and CPU?
5. Explain the power management in mobile devices?

1.9 ACTIVITIES

1. Make a case study on different display used in smartphones.

1.10 FURTHER READING AND REFERENCES

1. <https://www.evelta.com/blog/a-quick-introduction-to-smartphone-architecture/>
2. <https://atechjourney.com/list-of-smart-phone-and-tablet-mobile-processors.html/>
3. <https://www.neowin.net/news/guide-to-smartphone-hardware-37-memory-and-storage/>
4. <https://www.slashdigit.com/10-types-of-smartphone-displays/>
5. <https://www.engadget.com/2012/05/22/the-engineer-guy-shows-how-a-smartphone-accelerometer-works/>
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