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**MSPM’S**

**Deogiri Institute of Engineering and Management Studies, Aurangabad**

**Project Topic**

Smartphone :

1) ONEPLUS 6

2) ASUS Zenfone max pro m1

Submitted By

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CERTIFICATE

This is to Certify that Ratnesh Gujarathi and Vidit Duggad has Completed Word Document Presentation of Computer Architecture and Organization on Survey of Oneplus 6 and Asus xenfone max pro m1. For the partial fulfillment of Continuous Assessment on date\_\_\_\_\_\_

**Name and Signature of Student Name and Signature of Subject Teacher**

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**Oneplus 6**

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Oneplus 6 was launched on May 2018 , 177 gm with 7.8 mm thickness,

Powered by Android 8.1 upgradable to 9.0 ; Oxygen OS 9.0.8 with storage variant 128/256, 6.28’’ FHD+ display with 1080x2280 pixels,

Camera charged 20mp 2160p, With Snapdragon 845 processor, battery upto 3300 mAh

Specification

## Basic parameter

## Dimensions

155.7x75.4x7.75 mm

### Weight

6.2 ounces (177g)

### Material

Glass

### Colors

Mirror Black/ Midnight Black/ Silk White/ Red

### Operating System

OxygenOS based on Android™ Oreo

### CPU

Qualcomm® Snapdragon 845 (Octa-core, 10nm, up to 2.8 GHz), within AIE

### GPU

Adreno 630

### Notification Light

RGB LED notification light

### Vibration

Haptic vibration motor

### RAM

6 GB / 8 GB LPDDR4X

### Storage

UFS 2.1 2-LANE 64 GB / 128 GB / 256 GB

### Sensors

Fingerprint, Hall, Accelerometer, Gyroscope, Proximity, RGB Ambient Light Sensor, Electronic Compass, Sensor Core

### Ports

USB 2.0, Type-C, Support USB Audio  
Dual nano-SIM slot  
3.5 mm audio jack

### Battery

3300 mAh (non-removable) Fast Charging (5V 4A)

### Buttons

Gestures and on-screen navigation support Alert Slider

### Audio

Bottom-facing speaker  
Noise cancellation support  
Dirac HD Sound®  
Dirac Power Sound®

### Unlock Options

### Fingerprint Face Unlock

## Connectivity

### LTE/LTE-A

DL 4CA/256QAM, UL CA/64QAM, 4x4 MIMO  
Supports up to DL CAT16/ UL CAT13 (1Gbps/150 Mbps) depending on carrier support

### Bands

FDD LTE:   
Band 1/2/3/4/5/7/8/12/17/18/19/20/25/26/28/29/66  
TDD LTE: Band 34/38/39/40/41  
TD-SCDMA: Band 34/39  
UMTS(WCDMA): Band 1/2/4/5/8/9/19  
CDMA: BC0/BC1  
GSM: 850/900/1800/1900 MHz

### Wi-Fi

2x2 MIMO, Wi-Fi 802.11 a/b/g/n/ac, 2.4G/5G

### Bluetooth

Bluetooth 5.0, support aptX & aptX HD

### NFC

NFC enabled

### Positioning

GPS, GLONASS, BeiDou, Galileo

### Display

Size: 6.28 inches (The corners of the screen are within a standard rectangle. Measured diagonally, the screen size is 6.28 inches in the full rectangle and 6.12 inches accounting for the rounded corners.)  
Resolution: 2280 x 1080 pixels  
Aspect Ratio: 19:9  
Type: Optic AMOLED  
Support sRGB, DCI-P3  
Cover Glass: 2.5D Corning® Gorilla® Glass 5

### Features

Adaptive Mode  
Reading Mode  
Night Mode  
Lift Up Display

## Camera

## Rear Camera - Primary

## MainSensor: Sony IMX 519 Megapixels: 16 Pixel Size: 1.22 µm OIS: Yes EIS: Yes Autofocus: PDAF Aperture: f/1.7

### Rear Camera - Secondary

### Sensor: Sony IMX 376K Megapixels: 20 Pixel Size: 1.0 µm Autofocus: PDAF Aperture: f/1.7

### Flash

Dual LED Flash

### Video

### 4K resolution video at 30/60 fps 1080P resolution video at 30/60 fps 720P resolution video at 30 fps Super Slow Motion: 1080p video at 240 fps, 720p video at 480 fps Time-Lapse Video Editor

### Features

Portrait, Pro Mode, Panorama, HDR, HQ, RAW Image

## Front Camera

### Front Camera

Sensor: Sony IMX 371  
Megapixels: 16  
Pixel Size: 1.0 µm  
EIS: Yes  
Autofocus: Fixed Focus

**Features**

Portrait, HDR, Screen Flash, Smile Capture, Face Beauty②

## Multimedia

### Audio Supported Formats

Playback: MP3, AAC, AAC+, WMA, AMR-NB, AMR-WB, WAV, FLAC, APE, OGG, MID, M4A, IMY

### Video Supported Formats

Playback: MKV, MOV, MP4, H.265(HEVC), AVI, WMV, TS, 3GP, FLV, WEBM  
Recording: MP4

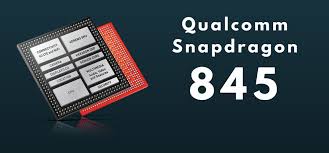
### Image Supported Formats

Playback: JPEG, PNG, BMP, GIF  
Output: JPEG

## In the box

1x OnePlus 6  
1x Screen Protector (pre-applied)  
1x Translucent Case (we recommend assembling the protective case from the bottom)  
1x OnePlus Fast Charge Type-C Cable  
1x OnePlus Fast Charge Power Adapter  
1x SIM Tray Ejector  
1x Quick Start Guide  
1x Safety Information

**Processor**

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**CPU**

**CPU Clock Speed:**Up to 2.8 GHz

**CPU Cores:**Qualcomm® Kryo™ 385 CPU, Octa-core CPU

**CPU Architecture:**64-bit

**Process**

**Process Technology:**10 nm (2nd generation)

**DSP**

**DSP Technology:**Qualcomm® Hexagon™ 685 DSP, Qualcomm All-Ways Aware™ technology

**Cellular Modem**

**Modem Name:**Qualcomm® Snapdragon™ X20 LTE modem

**Multi SIM:**Dual SIM Dual VoLTE (DSDV)

**Next-generation Calling Services:**VoLTE with SRVCC to 3G and 2G, HD and Ultra HD Voice (EVS), CSFB to 3G and 2G

**LTE Category**

**Downlink LTE Category:**LTE Category 18

**Uplink LTE Category:**LTE Category 13

**LTE Downlink Features**

**Downlink LTE Streams:**Maximum 12 spatial streams

**Downlink Carrier Aggregation:**5x20 MHz carrier aggregation

**Downlink LTE MIMO:**Up to 4x4 MIMO on three carriers

**Downlink QAM:**Up to 256-QAM

**LTE Uplink Features**

**Uplink Technology:**Qualcomm® Snapdragon™ Upload+, Uplink Data Compression (UDC)

**Uplink Carrier Aggregation:**2x20 MHz carrier aggregation

**Uplink QAM:**Up to 64-QAM

**LTE Speed**

**LTE Peak Download Speed:**1.2 Gbps

**LTE Peak Upload Speed:**150 Mbps

**Cellular Technology**

**Cellular Technology:**WCDMA (DB-DC-HSDPA, DC-HSUPA), TD-SCDMA, CDMA 1x, EV-DO, GSM/EDGE

**LTE Technology:**LTE FDD, LTE TDD including CBRS support, LAA, LTE Broadcast

**Wi-Fi**

**Wi-Fi Standards:**802.11ad, 802.11ac Wave 2, 802.11a/b/g, 802.11n

**Wi-Fi Spectral Bands:**2.4 GHz, 5 GHz, 60 GHz

**Peak speed:**867 Mbps

**Channel Utilization:**20/40/80 MHz

**MIMO Configuration:**2x2 (2-stream)

**Peak QAM:**256 QAM

**Wi-Fi Features:**MU-MIMO, Multi-gigabit Wi-Fi, Dual-band simultaneous (DBS), Integrated baseband

**Bluetooth**

**Bluetooth Version:**Bluetooth 5.0

**NFC**

**Near Field Communications:**Supported

**Location**

**Satellite Systems Support:**Beidou, Galileo, GLONASS, GPS, QZSS, SBAS

**Location Support:**Qualcomm® Location

**Global Emergency Services Support:**Assisted GPS, OTDOA (LTE-based positioning)

**Advanced Location Features:**Sensor-assisted Navigation, Low Power Geofencing and Tracking, Pedestrian Navigation

**RF**

**RFFE:**Qualcomm® RF Front-End (RFFE) solution

**USB**

**USB Version:**USB 3.1

**Camera**

**Image Signal Processor:**Qualcomm Spectra™ 280 image signal processor, Dual 14-bit ISPs

**Dual Camera, MFNR, ZSL, 30fps:**Up to 16 MP

**Single Camera MFNR, ZSL, 60fps:**Up to 16 MP

**Single Camera, MFNR, ZSL, 30fps:**Up to 32 MP

**Single Camera, MFNR:**Up to 48 MP

**Single Camera:**Up to 192 MP

**Camera Features:**Active Depth Sensing, Hardware Accelerated Face Detection, Hybrid Autofocus, Multi-frame Noise Reduction (MFNR)

**Video Capture (30 FPS):**4K HDR video capture

**Slow Motion Video Capture:**4K HDR @ 60 FPS, 720p @ 480 FPS

**Video Capture Formats:**HDR10, HLG, HEVC

**Video Capture Features:**Rec. 2020 color gamut video capture, Up to 10-bit color depth video capture

**Video**

**Video Playback:**Up to 4K Ultra HD video playback @ 60 fps

**Codec Support:**H.265 (HEVC)

**Video Software:**Accelerated Electronic Image Stabilization, Motion Compensated Temporal Filtering (MCTF), Rec. 2020 color gamut video capture, Up to 10-bits per color video capture

**Display**

**Max On-Device Display:**4K Ultra HD

**Max External Display:**4K Ultra HD

**UI FPS:**Up to 60 FPS

**Color Depth:**Up to 10-bit

**Color Gamut:**Rec2020

**Standards:**ULTRA HD PREMIUM-ready

**General Audio**

**Audio Technology:**Qualcomm TrueWireless™ Technology, Qualcomm® Broadcast Audio technology, Qualcomm Aqstic™ audio technology, Qualcomm® aptX™ audio technology

**Qualcomm® aptX™ audio playback support:**Qualcomm® aptX™, Qualcomm® aptX™ HD

**Audio Playback**

**Playback Dynamic Range:**130dB

**Total Harmonic Distortion + Noise (THD+N), Playback:**-109dB

**Sampling, Playback:**44.1kHz

**PCM, Playback:**Up to 384kHz/32bit

**Additional Playback Features:**Native DSD support (DSD64/DSD128), DoP (DSD over PCM)

**Amplifier output power:**Up to 4W

**Speaker protection:**Speaker protection

**Audio Recording**

**Total Harmonic Distortion + Noise (THD+N), Record:**-103dB

**Sampling, Record:**Up to 192kHz/24bit

**Recording Dynamic range:**109dB

**GPU**

**GPU Name:**Qualcomm® Adreno™ 630 GPU

**API Support:**OpenGL® ES 3.2, Vulkan® 1.1, OpenCL™ 2.0 full, DX12

**Power Consumption**

**Audio playback:**34mW for high performance mode

**Low power voice activation:**0.65mA

**Charging**

**Qualcomm® Quick Charge™ Support:**Qualcomm® Quick Charge™ 4 technology

**Security Support**

**Secure Processing Unit:**Biometric Authentication (Fingerprint, Iris, Voice, Face), Mobile Payments, WiFi-Protect

**Security Features:**Camera Security, Crypto Engine, Key Provisioning Security, Malware Protection, Qualcomm® Content Protection, Qualcomm® Mobile Security, Qualcomm® Processor Security, Qualcomm® Trusted Execution Environment, Secure Boot, Secure Token

**Memory**

**Memory speed:**1866MHz

**Memory Type:**LPDDR4x, Dual-Channel

**Storage**

**UFS:**UFS2.1 Gear3 2L

**SD:**SD 3.0 (UHS-I)

**ASUS ZENFONE MAX PRO M1**

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Asus zenfone max pro m1 was launched on May 2018 , 180 gm with 8.5 mm thickness, Powered by Android 8.1 upgradable to 9.0 ; Stock OS with storage variant 32/64 with microSd card slot, 5.99’’ FHD+ display with 1080x2180 pixels, Camera charged 16mp 2160p, With Snapdragon 636 processor, battery upto 5000 mAh

Specification

Capacity

**Internal storage**

eMCP 5.1 32GB / 64GB

**MicroSD card**

Supports up to 2TB

**Google Drive**

100GB free space (1 year)

Weight and Dimensions

159mm  
(6.25 inches)76mm  
(2.99 inches)8.45mm  
(0.33 inches)

**Weight:** 180 grams (6.34 ounces)

Display

6-inch Full HD+ (2160 by 1080) 18:9 Full View IPS display

Front 2.5D curved glass display

1500:1 contrast ratio

85% NTSC color gamut

450nits brightness

404ppi pixel density

Capacitive touch panel with 10 points multi-touch

Processor

**CPU:**Qualcomm® Snapdragon™ 636 Mobile Platform with 14nm, 64-bit Octa-core Processor  
(Snapdragon™ 636 performance is 1.54x better than Snapdragon™ 625)

**GPU:**Qualcomm® Adreno™ 509

Memory

LPDDR4X 3GB / 4GB / 6GB

Main Rear Camera

13MP / 16MP

Up to F2.0 aperture

Up to 25mm equivalent focal length in 35mm film camera

Phase-detection autofocus

LED flash

**Camera modes:**

HDR

Effects

Redeye Reduction

Beauty shot

Continuous Shot

Scene mode

Portrait mode

Second Rear Camera

5MP

Portrait mode for depth sensing

Front Camera

8MP / 16MP

Up to 26mm equivalent focal length in 35mm film camera

85° field of view

Softlight LED flash

Face recognition unlock

**Camera modes:**

HDR

Effects

Redeye Reduction

Beauty shot

Selfie Mirror

Continuous Shot

Scene mode

Portrait mode

Video Recording

4K UHD (3840 by 2160) video recording for main rear camera

1080p FHD video recording at 30 fps

720p HD video recording at 30 fps

Take still photo while recording video

Audio

**Speaker**

5-magnet loudspeaker

**Audio Output**

PMIC internal NXP smart amplifier

**Microphone**

Dual microphones with ASUS Noise Reduction Technology

**FM Receiver**

FM radio

Wireless Technology

WLAN 802.11 b/g/n 2.4GHz

Bluetooth 5.0

Bluetooth HID

Wi-Fi direct

WiFi display

NFC (optional)

Navigation

GPS, AGPS, GLO, BDS

SIM Cards

**Triple slots: Dual SIM & one microSD card**

Slot 1: 2G/3G/4G Nano SIM card

Slot 2: 2G/3G/4G Nano SIM card

Both SIM card slots support 4G LTE network band. But only one SIM card can connect to 4G LTE service at a time.

Slot 3: supports up to 2TB microSD card

Network Standard

GSM, WCDMA, FDD-LTE, TD-LTE

**Data rate**

LTE: Cat5 UL 75 Mbps / Cat4 DL 150 Mbps (A version)

LTE: Cat5 UL 75 Mbps / Cat13 DL 400 Mbps (B version)

DC-HSPA+: UL 5.76 / DL 42 Mbps

2CA support (B version)

**A version**

FDD-LTE (Bands 1, 3, 5, 7, 8, 20)

TDD-LTE (Band 40)

Supports VoLTE

WCDMA (Bands 1, 5, 8)

EDGE/GPRS/GSM (Bands 2, 3, 5, 8)

**B version**

FDD-LTE (Bands 1, 2, 3, 5, 7, 8, 18, 19, 26, 28)

TDD-LTE (Bands 38, 39, 40, 41)

Supports VoLTE, with 2CA

WCDMA (Bands 1, 2, 5, 6, 8, 19)

EDGE/GPRS/GSM (Bands 2, 3, 5, 8)

ASUS phone 4G/LTE band compatibility varies by region, please check compatibility with local carriers.

Sensor

Rear fingerprint sensor (0.3 seconds unlock, supports 5 fingerprints), Damp finger recognition, Accelerator, Gyroscope, E-Compass, Proximity sensor, Ambient light sensor

External Buttons and Connectors

Fingerprint sensor

On/Off   
Sleep/WakeVolume up/down3.5mm audio jack   
(1 Headphone/Mic-in)Built-in speakerUSB connector

Battery

5000mAh capacity with fast charging (0-100% in 2 hours 42 minutes)

Up to 35 days of 4G standby

Up to 42 hours of 3G talk time

Up to 12 hours of gaming

Up to 20 hours of YouTube playback

Up to 28 hours Wi-Fi web browsing

Power Adapter

**Output:** 5V 2A 10W

**Operating System**

**Pure Android™ 8.1 Oreo™**

**In the Box**

ZenFone Max Pro with Android™ 8.1 Oreo™

ASUS earphone with microphone (optional)

Micro-USB cable

MaxBox (optional)

Ejector pin (SIM tray needle)

USB power adapter

Documentation (user guide, warranty card)

Clear soft bumper (optional)

**Processor**

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**CPU**

**CPU Clock Speed:**Up to 1.8 GHz

**CPU Cores:**Qualcomm® Kryo™ 260 CPU, Octa-core CPU

**CPU Architecture:**64-bit

**Process**

**Process Technology:**14 nm

**DSP**

**DSP Technology:**Qualcomm® Hexagon™ 680 DSP, Qualcomm All-Ways Aware™ technology

**Cellular Modem**

**Modem Name:**Qualcomm® Snapdragon™ X12 LTE modem

**Multi SIM:**LTE Dual SIM

**Next-generation Calling Services:**VoLTE with SRVCC to 3G and 2G, Voice over Wi-Fi (VoWiFi) with LTE call continuity, HD and Ultra HD Voice (EVS)

**LTE Category**

**Downlink LTE Category:**LTE Category 12

**Uplink LTE Category:**LTE Category 13

**LTE Downlink Features**

**Downlink Carrier Aggregation:**3x20 MHz carrier aggregation

**Downlink QAM:**Up to 256-QAM

**LTE Uplink Features**

**Uplink Technology:**Qualcomm® Snapdragon™ Upload+

**Uplink Carrier Aggregation:**2x20 MHz carrier aggregation

**Uplink QAM:**Up to 64-QAM

**LTE Speed**

**LTE Peak Download Speed:**600 Mbps

**LTE Peak Upload Speed:**150 Mbps

**Cellular Technology**

**Cellular Technology:**WCDMA (DB-DC-HSDPA, DC-HSUPA), TD-SCDMA, CDMA 1x, EV-DO, GSM/EDGE

**LTE Technology:**Qualcomm® Snapdragon™ All Mode, LTE TDD, LTE FDD, LTE Broadcast

**Wi-Fi**

**Wi-Fi Standards:**802.11ac Wave 2, 802.11a/b/g, 802.11n

**Wi-Fi Spectral Bands:**2.4 GHz, 5 GHz

**Peak speed:**433 Mbps

**Channel Utilization:**20/40/80 MHz

**MIMO Configuration:**1x1 (1-stream)

**Peak QAM:**256 QAM

**Wi-Fi Features:**MU-MIMO, Integrated baseband

**Bluetooth**

**Bluetooth Version:**Bluetooth 5.0

**NFC**

**Near Field Communications:**Supported

**Location**

**Satellite Systems Support:**Beidou, QZSS, SBAS, GPS, Galileo, GLONASS

**Global Emergency Services Support:**Assisted GPS, OTDOA (LTE-based positioning)

**Advanced Location Features:**Sensor-assisted Navigation, Low Power Geofencing and Tracking

**RF**

**RFFE:**High-power transmit (HPUE), Qualcomm® Adaptive Antenna Tuning

**USB**

**USB Version:**USB 3.1

**Camera**

**Image Signal Processor:**Qualcomm Spectra™ 160 image signal processor, 14-bit, 2x Image Signal Processor (ISP)

**Dual Camera:**Up to 16 MP

**Single Camera:**Up to 24 MP

**Camera Features:**Hybrid Autofocus, Optical Zoom, Qualcomm® Clear Sight™ camera features, Zero Shutter Lag

**Video Capture (30 FPS):**4K Ultra HD video capture

**Slow Motion Video Capture:**1080p @ 120 FPS

**Video**

**Video Playback:**Up to 4K Ultra HD video playback

**Codec Support:**H.265 (HEVC), H.264 (AVC), VP8, VP9

**Display**

**Max On-Device Display:**FHD+

**Max External Display:**Up to 1080p

**General Audio**

**Audio Technology:**Qualcomm Aqstic™ audio technology, Qualcomm® aptX™ audio technology

**Qualcomm® aptX™ audio playback support:**Qualcomm® aptX™ HD, Qualcomm® aptX™

**Audio Playback**

**Playback Dynamic Range:**130dB

**Total Harmonic Distortion + Noise (THD+N), Playback:**-109dB

**Sampling, Playback:**44.1kHz

**PCM, Playback:**Up to 192kHz/24bit

**Amplifier output power:**Up to 4W

**Speaker protection:**Speaker protection

**Audio Recording**

**Total Harmonic Distortion + Noise (THD+N), Record:**-103dB

**Sampling, Record:**Up to 192kHz/24bit

**Recording Dynamic range:**109dB

**GPU**

**GPU Name:**Qualcomm® Adreno™ 509 GPU

**Power Consumption**

**Audio playback:**26mW for high performance mode

**Low power voice activation:**0.65mA

**Charging**

**Qualcomm® Quick Charge™ Support:**Qualcomm® Quick Charge™ 4 technology

**Security Support**

**Security Features:**Qualcomm® Processor Security, Application Security, Smart Camera

**Memory**

**Memory speed:**1333MHz

**Memory Type:**LPDDR4, Dual-Channel

**RAM:**8 GB RAM

**Architecture**

The word "architecture" typically refers to building design and construction. In the computing world, "architecture" also refers to design, but instead of buildings, it describes the design of computer systems. Computer architecture is a broad topic that includes everything from the relationship between multiple computers (such as a "client-server" model) to specific components inside a computer.

The most important type of hardware design is a computer's processor architecture. The design of the processor determines what software can run on the computer and what other hardware components are supported.

A processor is the logic circuitry that responds to and processes the basic instructions that drive a computer. The four primary functions of a processor are fetch, decode, execute and writeback.

The basic elements of a processor:

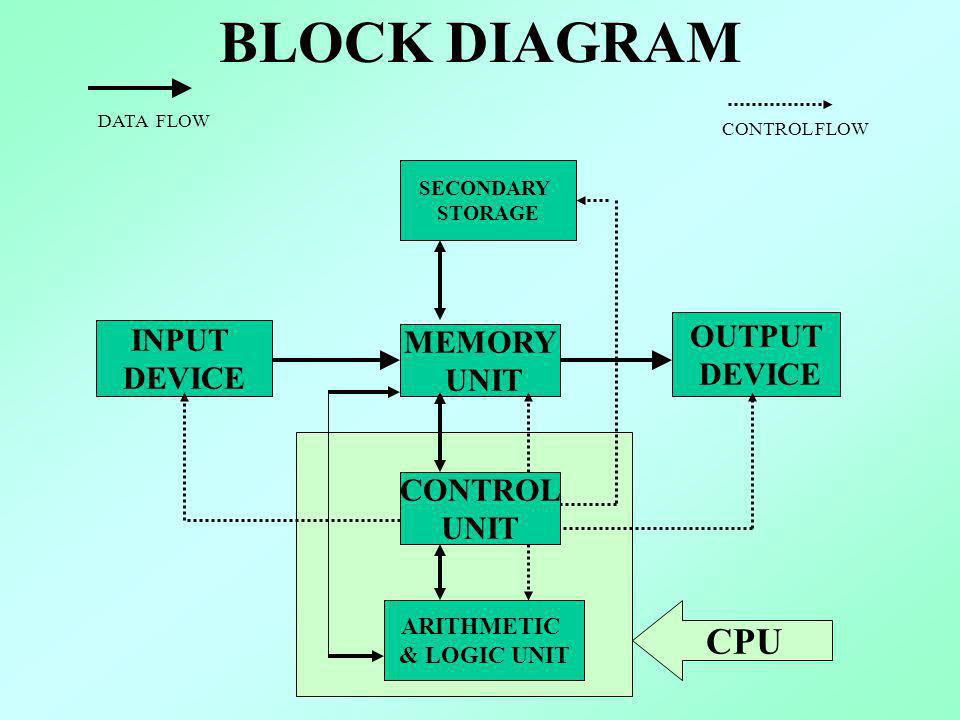
The arithmetic logic unit (ALU), which carries out arithmetic and logic operations on the operands in instructions.

The floating point unit (FPU), also known as a math coprocessor or numeric coprocessor, a specialized coprocessor that manipulates numbers more quickly than the basic microprocessor circuitry can.

Registers, which hold instructions and other data. Registers supply operands to the ALU and store the results of operations.

L1 and L2 cache memory. Their inclusion in the CPU saves time compared to having to get data from random access memory (RAM).

Most processors today are multi-core, which means that the IC contains two or more processors for enhanced performance, reduced power consumption and more efficient simultaneous processing of multiple tasks (s*ee:* parallel processing). Multi-core set-ups are similar to having multiple, separate processors installed in the same 2



computer, but because the processors are actually plugged into the same socket, the connection between them is faster.

The term *processor* is used interchangeably with the term central processing unit (CPU), although strictly speaking, the CPU is not the only processor in a computer. The GPU (graphics processing unit) is the most notable example but the hard drive and other devices within a computer also perform some processing independently. Nevertheless, the term *processor* is generally understood to mean the CPU.

The processor in a personal computer or embedded in small devices is often called a microprocessor. That term simply means that the processor's elements are contained on a single integrated circuitry (IC) chip.

The main Two companies in mobile or smartphone for CPU making are Qualcomm Snapdragon and MediaTek helio rest various companies make their own CPU’s like Samsung - Exynos, Apple - Bionic, Honor and Huaweii with Kirin

## Storage in Mobile Devices

## The ROM on smartphones

ROM (Read Only Memory) is a form of data storage. This type of memory keeps the saved data even if the device power is off. The word Read-only identifies it as "read-only memory", since the reprogramming process is generally infrequent, comparatively slow, and often does not permit random access writes to individual memory locations. It equals a hard disk in a computer, storing various of files, including videos, songs, photos, and system software, etc. At present, most smartphones are equipped with 16GB, 32GB, 64GB, or even 128GB, 256GB large ROM. But we have to pay attention that in phones the ROM is not described with ROM but with storage.

**A New Concept of Android Rom**

A file containing the executable instructions (a system image) of an Android OS and affiliated apps. The "stock ROM" comes installed on the phone or tablet, while a "custom ROM" comes from a third party. The custom ROM is either a uniquely modified OS, such as Cyanogen, or a stock version made available for older devices or for new devices before the vendor release date.

## The RAM on smartphones

RAM (Random Access Memory) is the memory where the software resides while it is running along with the data it is using. RAM is used by both OS and application software.

RAM is very fast but volatile, meaning that all information is lost when electric power is cut off, allowing data to be read or written irrespective of the physical location of data inside the memory. Devices with more RAM can run more complex software and multiple applications at the same time.

In smartphones, a special type of RAM called LPDDR is used, which consumes little energy, heats up very little, is very small and, of course, is rather expensive. Currently, the most common RAMs are LPDDR2, LPDDR3 and LPDDR4. These are the last three generations of this kind of memory for mobile devices. The main difference between each is that with each new generation, the transmission speed is doubled.

**MicorSD Cards**

The **microSD** removable miniaturized Secure Digital flash memory cards were originally named **T-Flash** or **TF**, abbreviations of **TransFlash**. TransFlash and microSD cards are functionally identical allowing either to operate in devices made for the other. SanDisk had conceived microSD when its chief technology officer and the chief technology officer of [Motorola](https://en.wikipedia.org/wiki/Motorola" \o "Motorola) concluded that current memory cards were too large for mobile phone.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Comparison of SD card capacity standards** | | | | | |  |
|  | | **SD** | **SDHC** | **SDXC** | **SDUC** |  |
| **Logo** | | [IMG_256](https://en.wikipedia.org/wiki/File:SD-Logo.svg) | [IMG_257](https://en.wikipedia.org/wiki/File:SDHC-Logo.svg) | [IMG_258](https://en.wikipedia.org/wiki/File:SDXC-Logo.svg) | [IMG_259](https://en.wikipedia.org/wiki/File:SDUC.svg) |  |
| **Capacity** | **Min** | 128MiB | 2GiB | 32GiB | 2TiB |  |
| **Max** | 2GiB | 32GiB | 2TiB | 128TiB |  |
| **Typical FS** | | FAT16 | FAT32 | FAT32/exFAT | exFAT |  |

**SD (SDSC)**

This is Second Generation Data Storing micro SD card which are generally 2.1mm thick but this were the first External Storing Data transfer cards.

**SDSC**

The Secure Digital High Capacity (SDHC) format, announced in January 2006 and defined in version 2.0 of the SD specification, supports cards with capacities up to 32 GiB (34359738368 bytes). The SDHC trademark is licensed to ensure compatibility.

SDHC cards are physically and electrically identical to standard-capacity SD cards (SDSC). The major compatibility issues between SDHC and SDSC cards are the redefinition of the Card-Specific Data (CSD) register in version 2.0 (see [below](https://en.wikipedia.org/wiki/SD_card" \l "Storage_capacity_calculations)), and the fact that SDHC cards are shipped preformatted with the [FAT32](https://en.wikipedia.org/wiki/FAT32" \o "FAT32) file system.

**SDXC**

The Secure Digital eXtended Capacity (SDXC) format, announced in January 2009 and defined in version 3.01 of the SD specification, supports cards up to 2 TiB (2199023255552 bytes), compared to a limit of 32 GiB for SDHC cards in the SD 2.0 specification. SDXC adopts Microsoft's [exFAT](https://en.wikipedia.org/wiki/ExFAT" \o "ExFAT) file system as a mandatory feature.

Version 3.01 also introduced the Ultra High Speed (UHS) bus for both SDHC and SDXC cards, with interface speeds from 50 MB/s to 104 MB/s for four-bit UHS-I bus.

Version 4.0, introduced in June 2011, allows speeds of 156 MB/s to 312 MB/s over the four-lane (two differential lanes) UHS-II bus, which requires an additional row of physical pins.

**SDUC**

The Secure Digital Ultra Capacity (SDUC) format, described in the SD 7.0 specification, and announced in June 2018, supports cards up to 128 TiB (140737488355328 bytes) and offers speeds up to 985 MB/s, regardless of form factor, either micro or full size, or interface type including UHS-I, UHS-II, UHS-III or SD Express.[[54]](https://en.wikipedia.org/wiki/SD_card" \l "cite_note-54) The SD Express interface can also be used with SDHC and SDXC cards.

