Mobile Application Development

1. Introduction:

1.1 What is Mobile technology?

- The Latin term mobile means "ability to move" or portable. Therefore mobile technology means, technology that is portable.
- **Mobile technology** is a type of technology in which a user utilizes a mobile phone to perform communications-related tasks, such as communicating with friends, relatives, and others. It is used to send data from one system to another.
- Mobile technology is technology that goes where the user goes. It consists of portable two-way communications devices, computing devices and the networking technology that connects them.
- Regardless of the context, mobile technology enables people to complete tasks from any location, adding more flexibility to tech users' everyday lives.

1.2 History of Mobile how it was developed?

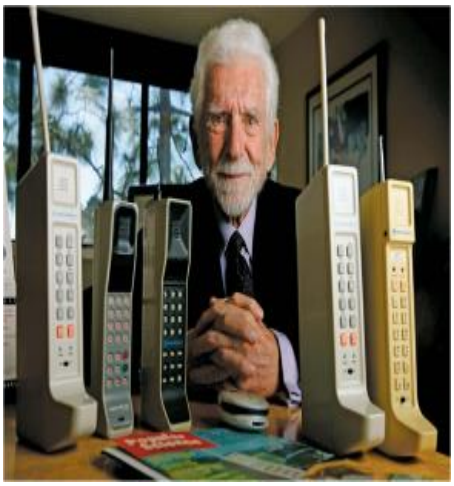
Mobile technology refers to the technology that is specifically designed to be used in mobile (or portable) devices. A mobile phone is a portable telephone that can make and receive calls over a radio frequency carrier while the user is moving within a telephone service area. The radio frequency link establishes a connection to the switching systems of a mobile phone operator, which provides access to the Public Switched Telephone Network (PSTN). Most modern mobile telephone services use cellular network architecture, and therefore mobile telephones are often also called cellular telephones or cell phones.

- **History of Mobile Phones:** Alexander Graham Bell invented telephone and 1878 he made the first phone call. Almost a century later Motorola introduced some of its first cell phones during the 1980s. No SMS No Touch Screen No GPS No Camera No Music No Bluetooth, Those phones were completely

different from the devices we have today and weren't nearly as cost effective and handy like today's phones.

- Early telephones were connected with wires. Every early phone call was put through by hand! The telephone operators spoke to each person who wanted to make a call and then connected them to the person they wanted to speak to.

- The first cell phone the first mobile phone developed by Motorola in 1973. It was Martin Cooper who placed the first call at AT&T Bells Labs from the streets of New York.These mobile phone that you could hold in your hand.
- This phone was very heavy and large. It was nicknamed "the brick" and weighed 1.1 kg and measured 23cm x 13cm x 4.5cm.You could only use the phone for 35 minutes and it took 10 hours to recharge!

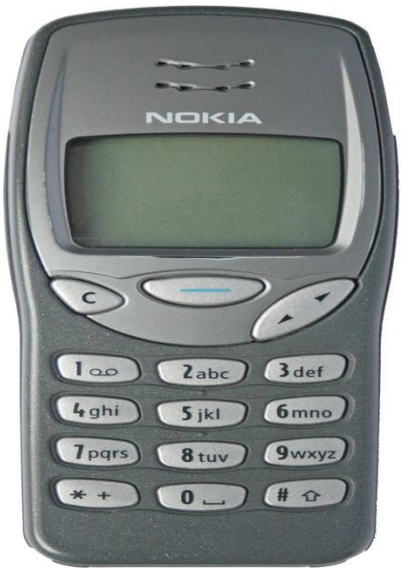


- 1984 Nokia Mobira Talkman the Phone weighed under 5 kgs and it was the world's first transportable phones. People want to be able to talk to each other when they are away from their homes and offices.
- These mobile phone services were built into cars, but they weren't very easy to use. To make a call you first had to speak to a telephone operator who put the call through for you. Only a few people could make calls at the same time.

- In 1989 Motorola Microtac was the smallest and lightest available phone at the time of its release. It was called MicroTac Pocket Cellular Telephone. It was designed in such a way that it could easily fit in any ones shirt pocket!

- First digital-sized mobile phone from Motorola introduced in 1992. This was the first handset that gave the world an idea of Flip Phones.
- The first Smartphone was developed by IBM & BellSouth which was released to the public in 1993.

- **1999 Nokia 8210** The lightest and smallest available Nokia phone at that time. This phone had the feature of speed dial in which the user can assign a name to each key on keypad. The phone uses SMS (Short Message Service) with predictive text input, with support for major European languages.



- The first cellular telephone to feature the new operating system was the T-Mobile G1, released on October 22, 2008. In 2012 Android became the most popular operating system for mobile devices, surpassing Apple's iOS, and, as of 2020, about 75 percent of mobile devices run Android.

- **2007 Apple iPhone** This phone completely changed the definition of a Smartphone. The iPhone is a line of smart phones designed by Apple Inc. This phone runs on Apples iOS mobile operating system.
- Mobile phones enable communication of voice, images, text and video. The important fact is that these could be shared with anyone in any corner of the world at the demand of the user.
- Communication is no longer the only service mobile technology offers. It offers a wide range of services such as access to the World Wide Web, view television and movies, interact with GPS, play games and read and respond to barcode and augmented reality messages.
- The history of mobile technologies originated with the limited use of radio frequencies, where the ability to establish simultaneous two-way communication (full duplex) was considered a technological feat. From the social perspective, mobile technologies began as a rare device used by limited personnel who needed to communicate to others in real time emergencies.
- From the user perspective, the history of mobile technologies began with the use of two way radios and evolved to the current state of prolific smart phones, tablets, and other mobile devices.
- Popularity of the technology sky rocketed with the invention of "smart phones".

2. History of Mobile Technology:

- The history of mobile phone and mobile technology can be said to have begun with the first generation of wireless mobile technologies.

5G (Fifth Generation):

- The latest generation of mobile technology, 5G, promises even faster data speeds, lower latency, and increased network capacity. It facilitates the development of new applications like augmented reality (AR), virtual reality (VR), and the Internet of Things (IoT). 5G is reported to be up to 100 times faster at sending and receiving signals than 4G.

4G (Fourth Generation)

- The first release of 4G was sometimes referred to as 3.9G or LTE (Long-Term Revolution). It was first launched in Oslo in 1998 before being adopted around the world.
- Referring to the fourth generation of cellular service, 4G operates on packet switching technology and organizes data into smaller groupings for fast transmission before reassembling at the destination.
- 4G networks significantly enhanced data speeds, allowing for high-quality video streaming, online gaming, and improved overall mobile internet performance. These give even faster speeds and make it possible to play complex games and watch films on a mobile phone.

3G (First Generation):

- 3G became a truly global standard and combined the best of competing technologies in a single standard. 3G evolutions were mainly centered around high speed data applications.
- 3G networks (UMTS FDD and TDD, CDMA2000 1x EVDO, CDMA2000 3x, TD-SCDMA, Arib WCDMA, EDGE, IMT-2000 DECT) are newer cellular networks that have data rates of 384kbit/s and more.
- 3G networks improved data transfer rates, enabling mobile internet access, video calling, and faster data services.
- These networks made it possible to download information much faster and surf (Browsing) the web on a mobile phone.

2G (First Generation):

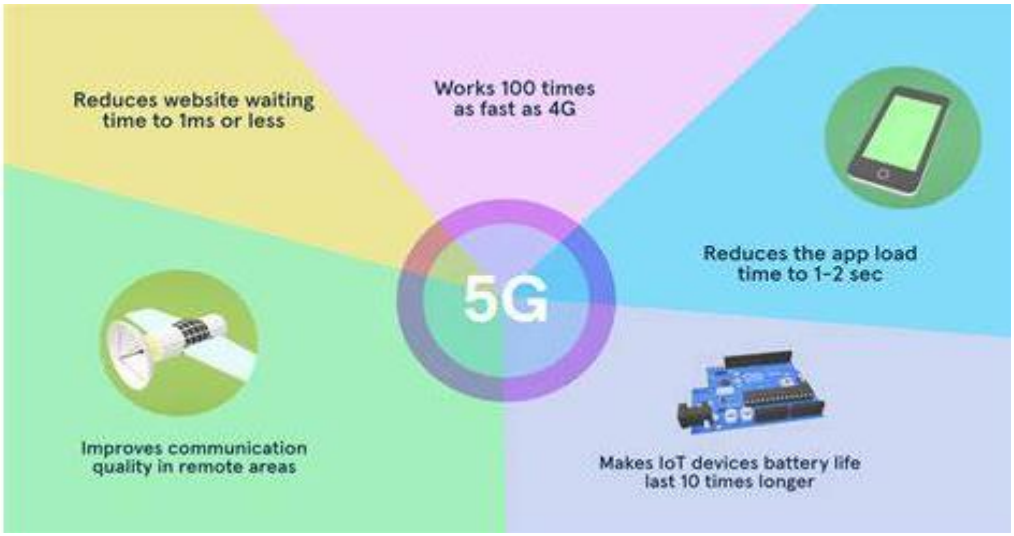
- 2G networks (GSM, CDMAOne, D-AMPS) are the first digital cellular systems launched early 1990s, offering improved sound quality, better security and higher total capacity.
- GSM supports circuit-switched data (CSD), allowing users to place dial-up data calls digitally, so that the network's switching station receives actual ones and zeroes rather than the screech of an analog modem. 2G networks with theoretical data rates up to about 144kbit/s.

- In 2G, roaming and SMS messaging were introduced and were later enhanced with GPRS (General Packet Radio Service) and GSM (Global System for Mobile Communication) for data communication.
- SMS messaging and GPRS became widely used for basic telemetry. Roaming made mobile technology suitable for deployments in multiple countries.
- Telenor was one of the first operators to offer M2M communications with things connected over the 2G network as early as the 1990s.

1G (First Generation):

- 1G network (NMT, C-Nets, AMPS, TACS) are considered to be the first analog cellular systems, which started early 1980s. There were radio telephone systems even before that.
- 1G used the analog system and signals. The drawback with analog signals is that they can't cover a long distance. It was used only for the voice services within one country no roaming initially phone was Large and Bulky.

5 G :



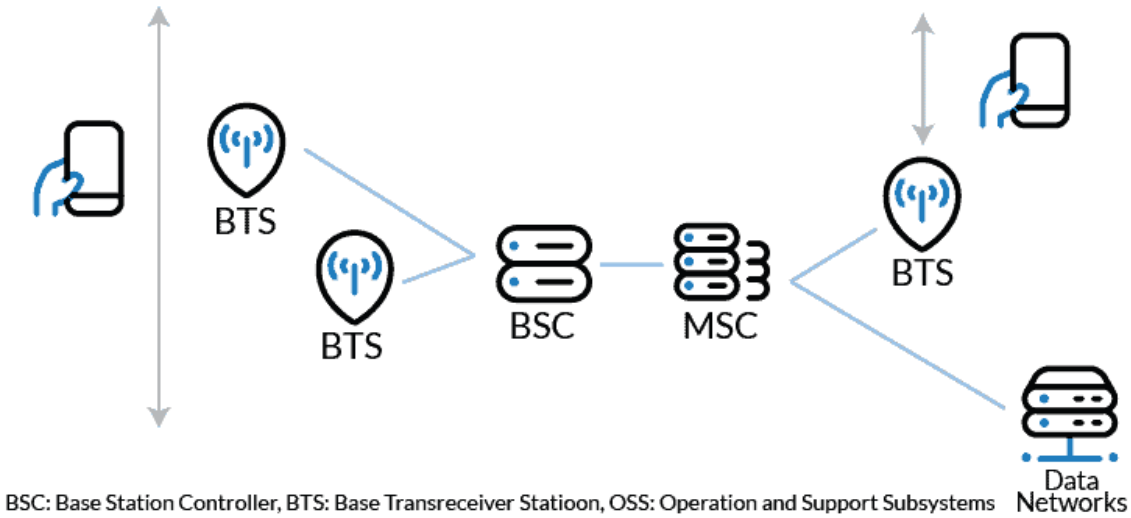
3. Different Types of Mobile Technologies:

- There are four main types of mobile networks – cellular communication, 4G networking, Wi-Fi, and Bluetooth connections. Below is an in-depth analysis of the different types of mobile technologies.
    - **3.1 Cellular Technology**
    - **3.2 Contention-Free**

3.1 Cellular Technology:

The most common model used for mobile networks is uniform hexagonal-shaped regions, called cells – hence the term "cellular technology."

- A cellular network is a communication system where the last link is wireless. Mobile signals travel from the transmitting device and onto a mobile base station. The base station transmits the signal to a switching center, and from here, it is sent over other base stations until it reaches the receiving device.



BSC: Base Station Controller, BTS: Base Transreceiver Statioon, OSS: Operation and Support Subsystems

- To make a phone call or browse the Internet with a mobile device, the device connects to a base station as a first step. A cellular network consists of thousands of base stations, and most of the earth's populated land area is covered by base stations. This association is one of the fundamental radio resource management problems. When a user is on the move, the mobile device must keep changing the association because each base station has limited coverage – this is known as handover. The other radio resource problem is that multiple devices need to communicate simultaneously and share capacity over the same channel. The solution to this problem is a medium access control (MAC) protocol. An MAC protocol multiplexes several data streams of different devices to share the same channel and deal with addressing issues – how a device obtains a channel when it needs one, and so forth. MAC protocols were originally designed for wired communications where several computers needed to transmit data packets simultaneously in a local area network (LAN). The physical media in wired networks is copper or fiber optic cables, which are reliable and have abundant bandwidth. There is little packet loss, and the MAC protocol designs are relatively simple. In mobile networks, the MAC protocol designs are complicated mainly due to diffraction, scattering, or reflection of a radio signal as it reaches its receiver.

3.2 Contention-Free

- In this design, a central controller coordinates resource allocation. The central controller may be a base station in a cellular network or an access point in a wireless local area network. Pre-determined or assigned network resources such as antennas, frequency bands, codes, and time slots are used by devices to send data packets. A central scheduler ensures that the transmissions of different devices do not conflict. Network providers can guarantee the quality of service (QOS) for this protocol design.

- Contention-free access protocols use five basic partitioning techniques as follows:

1. **Frequency Division Multiple Access (FDMA) –** The available bandwidth is divided into equal bands so that each station can be allocated its own band. Guard bands are also added so that no two bands overlap to avoid crosstalk and noise.
2. **Time Division Multiple Accesses (TDMA) –**In this, the bandwidth is shared between multiple stations. To avoid collision time is divided into slots and stations are allotted these slots to transmit data. However there is a overhead of synchronization as each station needs to know its time slot. This is resolved by adding synchronization bits to each slot. Another issue with TDMA is propagation delay which is resolved by addition of guard bands.
3. **Orthogonal Frequency Division Multiple Access (OFDMA) –** In OFDMA the available bandwidth is divided into small subcarriers in order to increase the overall performance, Now the data is transmitted through these small subcarriers. it is widely used in the 5G technology.
4. **Spatial Division Multiple Access (SDMA) –** SDMA uses multiple antennas at the transmitter and receiver to separate the signals of multiple users that are located in different spatial directions. This technique is commonly used in MIMO (Multiple-Input, Multiple-Output) wireless communication systems.
5. **Spread-spectrum multiple Access (SSMA):** This is a class of channel partitioning techniques combining frequency and time multiplexing. Signals have a bigger bandwidth than the information data rate.

Different Types of Mobile Technology:

- Mobile technology refers to any technology designed to be used on a mobile device, such as smart phones or tablets. It encompasses a wide range of technologies, including mobile apps, mobile websites, and mobile operating systems. Mobile technology has become increasingly popular in recent years as more and more people rely on their mobile devices for everyday tasks such as communication, entertainment, and productivity.

Cellular Technology:

- Cellular technology is one of the most popular types of mobile technologies today. It refers to cellular networks, which allow mobile devices to connect to the internet and make phone calls. With cellular technology, users can access various services and applications on their smart phones or tablets, such as email, social media, streaming videos, and online shopping.
- Cellular networks operate through radio networks distributed via cell towers, which allows mobile devices to automatically switch frequencies to their nearest geographical tower without interruption.
- The widespread adoption of cellular technology has revolutionized communication and made it easier for people to stay connected wherever they go.

WiFi :

- The next type of wireless mobile technology is Wi-Fi, which is highly popular. It allows devices to connect to the Internet wirelessly, allowing users to access online resources without needing a physical connection. WiFi technology uses radio waves to transmit data between devices and a wireless router, enabling seamless communication and internet access.
- With the increasing demand for connectivity on the go, WiFi technology has become essential in homes, offices, public spaces, and even vehicles. Its widespread availability and ease of use have made it a preferred choice for connecting smart phones, tablets, laptops, and other mobile devices to the Internet.

5G:

- The latest generation of communication, 5G, has brought with it a plethora of exciting benefits. With faster speeds, reduced latency, and more reliable

connectivity, it has revolutionized how we communicate. We can now enjoy lightning-fast data transmission, seamless connectivity for multiple devices simultaneously, and enhanced coverage, ensuring a more reliable connection.

4G :

- 4G networking is the fourth generation of mobile technology, providing faster data speeds and improved network performance compared to its predecessor, 3G. With 4G, users can experience download speeds of up to 100 megabits per second (Mbps), making activities such as streaming high-definition videos and downloading large files much quicker and more efficient.

Bluetooth:

- Rather than connect devices to the internet, Bluetooth networks connect devices to other devices via short-wavelength radio waves. With Bluetooth technology, users can quickly pair devices such as headsets and speakers with desktops, laptops, and phones.

SMS:

- SMS stands for Short Message Service. It is a text messaging service that allows the exchange of short text messages between mobile devices. SMS messages typically have a maximum length of 160 characters and can be sent and received on various mobile networks. But with the introduction of advanced technologies and updates, the limit has increased to over 700 while maintaining the same concept.

MMS:

- MMS stands for Multimedia Messaging Service. It is a standard way to send multimedia content such as images, videos, audio files, and contact cards between mobile devices using a cellular network. MMS is an extension of the Short Message Service (SMS), which is used for sending text messages.

Key Mobile Application Services :

Certainly! When it comes to **mobile application services**, there are several crucial aspects to consider. Let's explore some of the key services:

1. **User Sign-up/Sign-in and Management**:
    - This service involves creating a seamless experience for users to register, sign in, and manage their accounts within the mobile app. It includes features like email-based registration, social login (such as Face book or Twitter), and password recovery.
2. **Social Login**:
    - Social login allows users to sign in to your app using their existing social media credentials (e.g., Face book, Google, Twitter). It simplifies the authentication process and enhances user convenience.
3. **Analytics and User Engagement**:
    - Analytics services help track user behavior within the app. By analyzing data such as user interactions, session duration, and conversion rates, you can make informed decisions to improve the app's performance and engagement.
4. **Push Notifications**:
    - Push notifications keep users informed and engaged by sending timely updates, reminders, or personalized messages directly to their devices. Effective push notification strategies can enhance user retention and drive app usage.
5. **Real Device Testing**:
    - Ensuring your app works flawlessly across various devices and operating systems is essential. Real device testing involves testing your app on actual devices (not just simulators) to identify any issues related to performance, compatibility, or usability.

Remember that these services play a critical role in delivering a successful mobile app experience. Whether you're developing for iOS, Android, or cross-platform, thoughtful implementation of these services contributes to user satisfaction and app success.

Android:

Introduction to Android:

When we talked about operating systems few years ago, the most common answers were Windows, Linux, and macOS operating system. However, with the undying competition in the mobile phones market, the next big thing entered was ANDROID, which in no time became the heart of smart phones. Android provides a rich application framework that allows you to build innovative apps and games for mobile devices in a Java language environment.

Android is a mobile operating system developed by Google, based on a modified version of the Linux kernel and other open source software and designed primarily for touch screen mobile devices such as smart phones and tablets. The Android Operating System is a Linux-based OS developed by the Open Handset Alliance (OHA). The Android OS was originally created by Android, Inc., which was bought by Google in 2005.

Open Handset Alliance - It's a consortium of 84 companies such as Google, Samsung, AKM, synaptics, KDDI, Garmin, Teleca, eBay, Intel etc. It was established on 5th November, 2007, led by Google. It is committed to advance open standards, provide services and deploy handsets using the Android Platform.

The android is a powerful operating system and it supports large number of applications in Smart phones. These applications are more comfortable and advanced for the users. The hardware that supports android software is based on ARM architecture platform. The android is an open source operating system means that it’s free and any one can use it.

In addition, Google has further developed Android TV for televisions, Android Auto for cars and Wear OS for wrist watches, each with a specialized user interface. Variants of Android are also used on game consoles, digital cameras, PCs and other electronics.

The android has got millions of apps available that can help you managing your life one or other way and it is available low cost in market at that reasons android is very popular.

The main advantage to adopting Android is that it offers a unified approach to application development. Developers need only develop for Android in general, and their applications should be able to run on numerous different devices, as long as the devices are powered using Android.

Android Features:

The important features of android are given below:

1) It is open-source.

2) Anyone can customize the Android Platform.

3) There are a lot of mobile applications that can be chosen by the consumer.

4) It provides many interesting features like weather details, opening screen, live RSS (Really Simple Syndication) feeds etc.

It provides support for messaging services (SMS and MMS), web browser, storage (SQLite), connectivity (GSM, CDMA, Blue Tooth, and Wi-Fi etc.), media, handset layout etc.

Android versions:

- Android has gone through quite a number of updates since its first release. Table 1-1 shows the various versions of Android and their codenames.

Table 1: A Brief history of Android Versions

Android Version	Release Date	Code Name
1.1	9 February 2009	**"Astro Boy"** and **"Bender"**
1.5	30 April 2009	Cupcake
1.6	15 September 2009	Donut
2.0/2.1	26 October 2009	Éclair
2.2	20 May 2010	Froyo
2.3	6 December 2010	Gingerbread
3.0	22 February 2011	Honeycomb
4.0	18 October 2011	Ice Cream sandwich
4.1 to 4.3	09 July 2012	Jelly Bean
4.4	31 October 2013	Kit Kat
5.0	12 November 2014	Lollipop
6.0	05 October 2015	Marshmallow
7.0	22 August 2016	Nougat
8.0	December 5, 2017	Oreo
9.0	August 6, 2018	Pie
10	September 3, 2019	Queen Cake
11	September 8, 2020	Red Velvet Cake
12	October 4, 2021	Snow Cone

Android version 1.5: Cup Cake

On April 2009, the Android 1.5 update, Cup Cake was released based on linux kernel 2.6/2.7. It has Virtual Keyboards, Video Recording, Auto –Pairing, & Stereo Support for Bluetooth, Use Pictures shown for favorites in Contacts & Few more.

Android version 1.6: Donut

In 2009, Google released the Android operating system version 1.5, which was internally named "Cupcake" and introduced significant updates and features to the

platform. Following Cupcake, Google continued its development, and later in 2009, they released Android version 1.6, which was internally nicknamed "Donut."It has improved Functionality (quick search box, Updated Camera, Gallery and voice search). Battery Usage Indicator, and support for Super-Sharp 480X800 pixel Screens.

Android version 2.0: Éclair

Android version 2.0, codenamed Éclair, was a major update to the Android operating system released in October 2009. It gave us improved typing speed on virtual Keyboard By using Multi touch Data, Auto Brightness, Improved Google Maps 3.1.2 with Navigation, Numerous New Camera features, including flash, Color effects, Macro focus, Picture Size, storage location and much more updates.

Android version 2.2: Froyo

Android 2.2, also known as "**Froyo**" (short for Frozen Yogurt), did indeed introduce significant improvements in voice control and search capabilities, allowing users to control their phones without touching them. You could also now installed apps on memory Card. For instance, they could send text messages, make calls, play music, search the web, or get directions by speaking commands to their device. Prior to this update, Android devices only allowed apps to be installed on the device's internal storage. In Froyo users gained the capability to install applications onto the external storage, typically referred to as the memory card.

Android version 2.3: Gingerbread

In these update, Android updates with user Interface design with increased simplicity and speed, support for multiple cameras on the device, new download manager, new audio effects and Native support for SIP VOIP internet telephony. With native SIP VOIP support, Android users gained the ability to make voice calls over Wi-Fi or mobile data networks, potentially reducing call costs and providing more flexibility in communication.

Android version 3.0: Honeycomb

Honeycomb stands out in Android history as the only version developed specifically for tablets. Interface elements like the virtual keyboard were optimized for bigger screens and you had support for multi-core processors, including the virtual keyboard, were designed to work better on devices with larger displays, providing a more comfortable and efficient user experience. Multi-core processors allow devices to execute

multiple tasks simultaneously, leading to improved performance and multitasking capabilities.

Android version 4.0: Ice Cream Sandwich

An Ice Cream Sandwich hit phones in 2011, bringing an all-new look and feel to Android. You could also now close apps with a quick swipe, shoot 1080p video and providing users with higher-quality video recording capabilities, unlock your phone with your face(facial recognition technology that allowed users to unlock their phones using their faces), where supported. Android introduced the ability to close apps quickly by swiping them away from the multitasking or recent apps menu.

Android version 4.1 to 4.3 Jelly bean

Android Jelly Bean made Google's OS more responsive than ever, improving search functionality and introducing the ability to share files with your friends using Android. Android Jelly Beam, a feature that allowed users to share content such as web pages, contacts, photos, videos, and more by simply tapping their devices together.

Android version 4.4: Kit Kat

It was launched on October 31, 2013. It was designed to require less RAM than before, in order to help its performance on phones with less than 1 Gigabyte of RAM.

Android version 5.0: Lollipop

Android Lollipop hit our phones in 2014 and brought multiple profiles on one device, the 'no interruptions' feature to get some peace and an all-new notifications bar. You could also now unlock your phone with a trusted Bluetooth device.

Ex: Family Sharing: A parent can set up separate user profiles for themselves and their children on a tablet. Each child can have their own profile with age-appropriate apps and settings, while the parent can have a profile with full access to all apps and settings.

Android version 6.0: Marshmallow

Android marshmallow was unveiled by Google in September 2015, improving battery life and adding Cool new features like now on tap and fingerprint sensor support.

Android version 7.0: Nougat

Nougat is the latest update of Android having multiple features like quick switch between apps, Multi – window view,multi locale language settings, over 1500 emoji including 72 new ones, Virtual Reality mode and much more.

Android version 8.0: Oreo

Android Oreo also introduces two major platform features: Android Go – a software distribution of the operating system for low-end devices – and support for implementing a hardware abstraction layer. It supports Notification grouping, Picture-in-picture support for video, Performance improvements and battery usage optimization, Support for auto fillers, Bluetooth 5, System-level integration with VoIP apps.

Android version 9.0: Pie

It was first announced by Google on March 7, 2018, but was released on July 25, 2018. Pie's most transformative change was its hybrid gesture/button navigation system, which traded Android's traditional "Back", "Home", and "Overview" keys for a large, multifunctional Home button and a small Back button that appeared alongside it as needed. It supports the following features:

- A "screenshot" button has been added to the power options.
- Richer messaging notifications, where a full conversation can be had within a notification, full-scale images.
- New user interface for the quick settings menu.
- An Adaptive Battery feature that maximizes battery power by prioritizing the apps you're most likely to use next.
- Improved Adaptive Brightness feature which modifies screen brightness based on your own personal preferences.
- New Back Button Icon in the navigation bar.

Android version 10: Queen Cake

Android 10 is the 10th major release and seventeenth version of Android, released on September 3, 2019. Most noticeably, the first Android version to shed its letter and be known simply by a number, with no dessert theme. However, there was a code name for Android 10 named "Queen Cake".

It supports the following features:

- Gesture Interface added in this release.
- Introduced swipe-driven approach to system navigation.
- Update the device tracking functions.
- Introduced dark theme.
- Introduces a new Live Caption feature that allows you to generate on-the-fly visual captions for any media playing on your phone

Android version 11: Red Velvet Cake

The version's most significant changes revolve around privacy. The update builds upon the expanded permissions system introduced in Android 10 and adds the ability for users to grant apps certain permissions – those related to location access, camera access, and microphone access – only on a limited, single-use basis. Although this version was marketed as Android 11 without a name for the desert, there was a code name for Android 11 which is named "Red Velvet Cake".

Features of Android 11.0:

- This version introduced the background location permission even deeper into the system and made it more difficult for apps to request.
- Android 11 removes an app's ability to see what other apps are installed on your phone.
- It refines the system notification area to emphasize and simplify conversation-related alerts.
- It introduces a new streamlined media player that contains controls for all audio and video-playing apps in a single space

Android version 12: Red Velvet Cake

Android 12 is the first software version to integrate an updated and completely overhauled take on that standard – something known as Material You. Material you brings a dramatically different look and feel to the entire Android experience, and it isn't limited only to system-level elements, either. Eventually, Android 12's design principles will stretch into both apps on your phone and Google services on the web.

It supports the following features:

- Material you and wallpaper-based theming (Accent colours picked from your wallpaper - optional).
- New Extra Dim Mode (Reduces screen brightness).

- Unified the WIFI and Mobile Data quick settings to bring up a mini-settings panel with both options.
- Scrolling Screenshots in supported apps.
- Privacy Dashboard.
- Hold the power button for the assistant gestures.
- Adaptive Charging added.
- Giving access to an approximate location instead of an accurate location.
- Universal device search

Features of Android:

Because Android is open source and freely available to manufacturers for customization, there are no fixed hardware or software configurations. However, Android itself supports the following features:

1. **Storage** — Uses SQLite, a lightweight relational database, for data storage.

2. **Connectivity** — Supports GSM/EDGE, IDEN, CDMA, EV-DO, UMTS, Bluetooth (includes A2DP and AVRCP), Wi-Fi, LTE, and WiMAX.

3. **Messaging** — Supports both SMS and MMS.

4. **Web browser** — based on the open source WebKit, together with Chrome's V8 JavaScript engine.

5. **Media support** — Includes support for the following media: H.263, H.264 (in 3GP or MP4 container), MPEG-4 SP, AMR, AMR-WB (in 3GP container), AAC, HE-AAC (in MP4 or 3GP container), MP3, MIDI, Ogg Vorbis, WAV, JPEG, PNG, GIF, and BMP.

6. **Hardware support** — Accelerometer Sensor, Camera, Digital Compass, Proximity Sensor, and GPS

7. **Multi-touch** — Supports multi-touch screens

8. **Multi-tasking** — Supports multi-tasking applications

9. **Flash support** — Android 2.3 supports Flash 10.1.

10. **Tethering** — Supports sharing of Internet connections as a wired/wireless hotspot.

Android Architecture:

Android architecture contains different number of components to support any android device needs. Android software contains an open-source Linux Kernel having collection of number of C/C++ libraries which are exposed through an application framework services. Among all the components Linux Kernel provides main functionality of operating system functions to smartphones and Dalvik Virtual Machine (DVM) provide platform for running an android application.

The main components of android architecture are following:-

- Applications
- Application Framework
- Android Runtime
- Platform Libraries
- Linux Kernel

1. Linux kernel — This layer contains all the low level device drivers for the various hardware components of an Android device. At the bottom of the layers is Linux - Linux 3.6 with approximately approximately 115 patches. This provides a level of abstraction between the device hardware and it contains all the essential hardware drivers drivers like camera, camera, keypad, keypad, display etc. Also, the kernel handles all the things that Linux is really good at such as networking and a vast array of device drivers, which take the pain out of interfacing to peripheral hardware.

2. Libraries — These contain all the code that provides the main features of an Android OS. On top of Linux kernel there is a set of libraries including open-source Web browser engine WebKit, well known library libc, SQLite database which is a useful repository for storage and sharing of application data, libraries to play and record audio and video, SSL libraries responsible for Internet security etc. The WebKit library provides functionalities for web browsing.

3. Android runtime — At the same layer as the libraries, the Android runtime provides a set of core libraries that enable developers to write Android apps using the Java programming language. The Android runtime also includes the Dalvik virtual machine, which enables every Android application to run in its own process, with its own instance of the Dalvik virtual machine (Android applications are compiled into Dalvik executables). Dalvik is a specialized virtual machine designed specifically for Android and optimized for battery-powered mobile devices with limited memory and CPU power.

4. Application framework — Exposes the various capabilities of the Android OS to application developers so that they can make use of them in their applications. The Application Framework layer provides many higher-level level services to applications in the form of Java classes. Application developers are allowed to make use of these services in their applications. The Android framework includes the following key services.

Activity Manager − Controls all aspects of the application lifecycle and activity stack.

Content Providers − Allows applications to publish and share data with other applications.

Resource Manager − Provides access to non-code embedded resources such as strings, strings, color settings and user interface layouts.

Notifications Manager − Allows applications to display alerts and notifications to the user.

View System − An extensible set of views used to create application user interfaces.

5. Applications - You will find all the Android application at the top layer. You will write your application to be installed on this layer only. Examples of such applications are Contacts Books, Browser, and Games etc.

Android - Application Components

Application components are the essential building blocks of an Android application. These components are loosely coupled by the application manifest file AndroidManifest.xml that describes each component of the application and how they interact.

There are following four main components that can be used within an Android application –

Sl.No	Components & Description
1	**Activities** They dictate the UI and handle the user interaction to the smart phone screen.
2	**Services** They handle background processing associated with an application.

3	**Broadcast Receivers** They handle communication between Android OS and applications.
4	**Content Providers** They handle data and database management issues.

1. Activities

An activity represents a single screen with a user interface, in-short Activity performs actions on the screen. For example, an email application might have one activity that shows a list of new emails, another activity to compose an email, and another activity for reading emails. If an application has more than one activity, then one of them should be marked as the activity that is presented when the application is launched.

An activity is implemented as a subclass of Activity class as follows –

```
public class MainActivity extends Activity {
}
```

2. Services

A service is a component that runs in the background to perform long-running operations. For example, a service might play music in the background while the user is in a different application, or it might fetch data over the network without blocking user interaction with an activity.

A service is implemented as a subclass of Service class as follows –

```
public class MyService extends Service {
}
```

3. Broadcast Receivers

Broadcast Receivers simply respond to broadcast messages from other applications or from the system. For example, applications can also initiate broadcasts to let other applications know that some data has been downloaded to the device and is available for them to use, so this is broadcast receiver who will intercept this communication and will initiate appropriate action.

A broadcast receiver is implemented as a subclass of BroadcastReceiver class and each message is broadcaster as an Intent object.

```
public class MyReceiver extends BroadcastReceiver {
        public void onReceive (context, intent){}
}
```

4. Content Providers

A content provider component supplies data from one application to others on request. Such requests are handled by the methods of the ContentResolver class. The data may be stored in the file system, the database or somewhere else entirely.

A content provider is implemented as a subclass of ContentProvider class and must implement a standard set of APIs that enable other applications to perform transactions.

```
public class MyContentProvider extends ContentProvider {
        public void onCreate(){}
}
```

5. Additional Components

There are additional components which will be used in the construction of above mentioned entities, their logic, and wiring between them. These components are –

S.No	Components & Description
1	**Fragments** Represents a portion of user interface in an Activity.
2	**Views** UI elements that are drawn on-screen including buttons, lists forms etc.
3	**Layouts** View hierarchies that control screen format and appearance of the views.
4	**Intents** Messages wiring components together.
5	**Resources** External elements, such as strings, constants and drawable pictures.
6	**Manifest** Configuration file for the application.

Exploring the Development Environment:

For developing application for android platform, you will require Integrated Development Environment (IDE). Android Studio is the official IDE for Android application development. Android Studio provides everything you need to start developing apps for Android, including the Android Studio IDE and the Android SDK tool.

1. **Android studio**
2. **Eclipse IDE**

Exploring the development environment in Android is crucial for anyone looking to build Android applications. Here's a breakdown of the essential components and steps involved:

Java or Kotlin: Android apps are primarily developed using either Java or Kotlin programming languages. Kotlin is the newer, preferred language for Android development due to its conciseness, safety features, and interoperability with Java.

Android Studio: This is the official Integrated Development Environment (IDE) for Android development, provided by Google. Android Studio offers a comprehensive suite of tools for designing, coding, testing, and debugging Android applications. It includes features like a visual layout editor, APK analyzer, and built-in emulator.

SDK Manager: The Software Development Kit (SDK) Manager is a tool within Android Studio that allows developers to download and manage the various SDK components necessary for Android development. This includes platform tools, system images for emulators, and additional libraries.

Emulator: Android Studio includes a built-in emulator that allows developers to test their apps on virtual devices with different configurations (e.g., screen size, Android version). This is useful for debugging and ensuring compatibility across various devices.

Device for Testing: While emulators are handy, testing on real devices is essential to ensure your app performs correctly across different hardware configurations. You can connect physical devices to your development machine via USB for testing.

Debugger: Android Studio provides a powerful debugger that allows developers to step through their code, set breakpoints, inspect variables, and analyze the runtime behavior of their applications. This is invaluable for identifying and fixing bugs.

Version Control: Version control systems like Git are commonly used in Android development to track changes to the codebase, collaborate with other developers, and manage different versions of the app.

Documentation and Community Resources: The Android developer website provides extensive documentation, tutorials, and API references to help developers learn and understand various aspects of Android development. Additionally, online forums like Stack Overflow and Reddit's r/androiddev community are valuable resources for seeking help and sharing knowledge with fellow developers.

Obtaining the Required Tools:

The first and most important piece of software you need to download is Android Studio After you have downloaded and installed Android Studio you can use the SDK Manager to download and install multiple versions of the Android SDK. Having multiple versions of the SDK available enables you to write programs that target different devices.

Android Studio:

Android Studio provides a unified environment where you can build apps for Android phones, tablets, Android Wear, Android TV, and Android Auto. Structured code modules allow you to divide your project into units of functionality that you can independently build, test, and debug. Android Studio is the official integrated development environment (IDE) for Android application development. It is based on the IntelliJ IDEA, a Java integrated development environment for software, and incorporates its code editing and developer tools. To support application development within the Android operating system, Android Studio uses a Gradlebased build system, emulator, code templates, and GitHub integration. Every project in Android Studio has one or more modalities with source code and resource files. These modalities include Android app modules, Library modules, and Google App Engine modules.

Android SDK:

The Android SDK (software development kit) is a set of development tools used to develop applications for Android platform. SDK provides a selection of tools required to build Android apps or to ensure the process goes as smoothly as possible. tools required to build Android apps or to ensure the process goes as smoothly as possible. The Android SDK comprises all the tools necessary to code programs from scratch and even test them. These tools provide a smooth flow of the development process from

developing and debugging, through to packaging. The Android SDK is compatible with Windows, macOS, and Linux, so you can develop on any of those platforms.

1. SDK tools

SDK tools are generally platform independent and are required no matter which android platform you are working on. When you install the Android SDK into your system, these tools get automatically installed. The list of SDK tools has been given below –

SL.NO	Tools & Description
1	**android** This tool lets you manage AVDs, projects, and the installed components of the SDK
2	**ddms** This tool lets you debug Android applications
3	**Draw 9-Patch** This tool allows you to easily create a Nine Patch graphic using a WYSIWYG editor
4	**emulator** This tools let you test your applications without using a physical device
5	**mksdcard** Helps you create a disk image (external sdcard storage) that you can use with the emulator
6	**proguard** Shrinks, optimizes, and obfuscates your code by removing unused code
7	**sqlite3** Lets you access the SQLite data files created and used by Android applications
8	**Traceview** Provides a graphical viewer for execution logs saved by your application
9	**Adb** Android Debug Bridge (adb) is a versatile command line tool that lets you communicate with an emulator instance or connected Android-powered device.

DDMS

- DDMS stands for Dalvik debug monitor server that provides many services on the device. The service could include message formation, call spoofing, capturing screenshot, exploring internal threads and file systems etc.
- Running DDMS from Android studio click on Tools>Android>Android device Monitor.

How it works

- In android, each application runs in its own process and each process run in the virtual machine. Each VM exposes a unique port, that a debugger can attach to.
- When DDMS starts, it connects to adb. When a device is connected, a VM monitoring service is created between adb and DDMS, which notifies DDMS when a VM on the device is started or terminated.

Sqlite3

- Sqlite3 is a command line program which is used to manage the SQLite databases created by Android applications. The tool also allows us to execute the SQL statements on the fly.
- There are two ways through which you can use SQLite, either from remote shell or you can use locally.

Android Emulator: -

- The Android Emulator simulates Android devices on your computer so that you can test your application on a variety of devices and Android API levels without needing to have each physical device.
- The emulator provides almost all of the capabilities of a real Android device. You can simulate incoming phone calls and text messages, specify the location of the device, simulate different network speeds, simulate rotation and other hardware sensors, access the Google Play Store, and much more.
- Testing your app on the emulator is in some ways faster and easier than doing so on a physical device. For example, you can transfer data faster to the emulator than to a device connected over USB.
- The emulator comes with predefined configurations for various Android phone, tablet, Wear OS, and Android TV devices.
- In short, An Android emulator is an Android Virtual Device (AVD) that represents a specific Android device. You can use an Android emulator as a target platform to run and test your Android applications on your PC. Using Android emulators is optional.

Android Virtual Device Manager: - An Android Virtual Device (AVD) is a configuration that defines the characteristics of an Android phone, tablet, Wear OS, Android TV, or Automotive OS device that you want to simulate in the Android

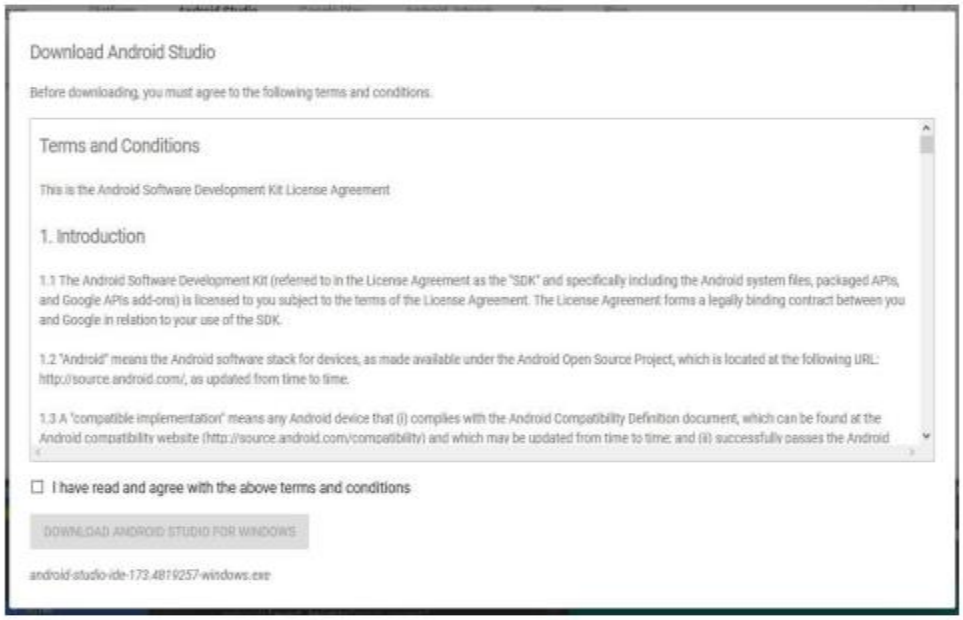
Emulator. The AVD Manager is interfaces you can launch from Android Studio that helps you create and manage AVDs. An AVD contains a hardware profile, system image, storage area, skin, and other properties.

Use the following steps to go through the installation process of Android Studio:

Step – 1: Head over to bellow link to get the Android Studio executable or zip file . https://developer.android.com/studio/#downloads

Step – 2: Click on the download android studio button

Click on the "I have read and agree with the above terms and conditions" checkbox followed by the download button.



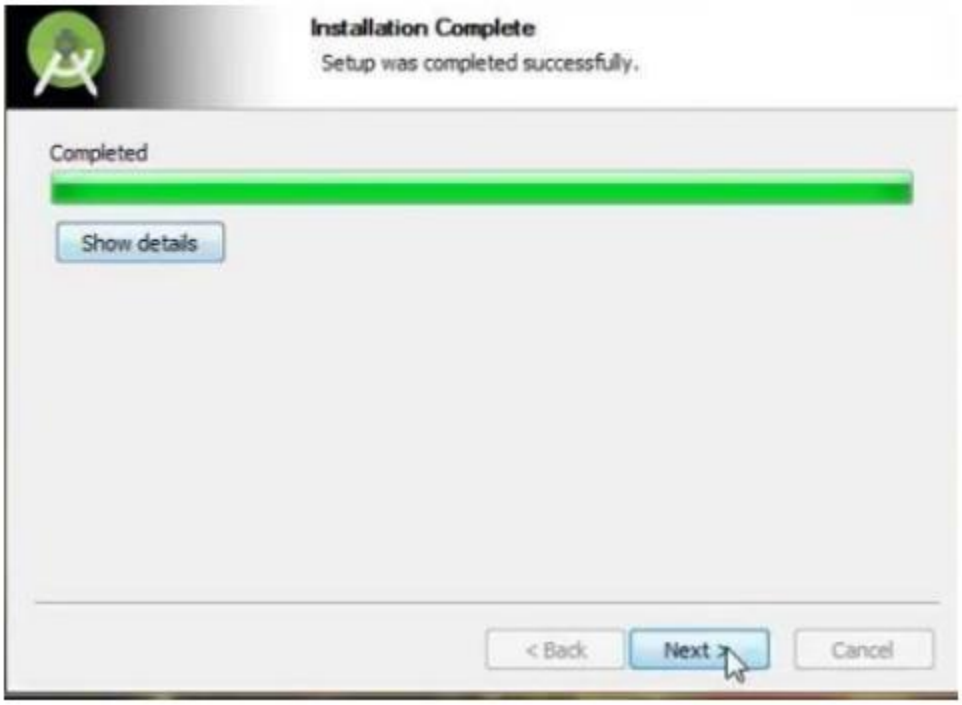
Click on save file button in the appeared prompt box and the file will start downloading.

Step – 3: After the downloading has finished, open the file from downloads and run it . It will prompt the following dialogue box

Click on next.

In the next prompt it'll ask for a path for installation. Choose a path and hit next.

Step – 4: It will start the installation, and once it is completed, it will be like the image shown below.



Click Next

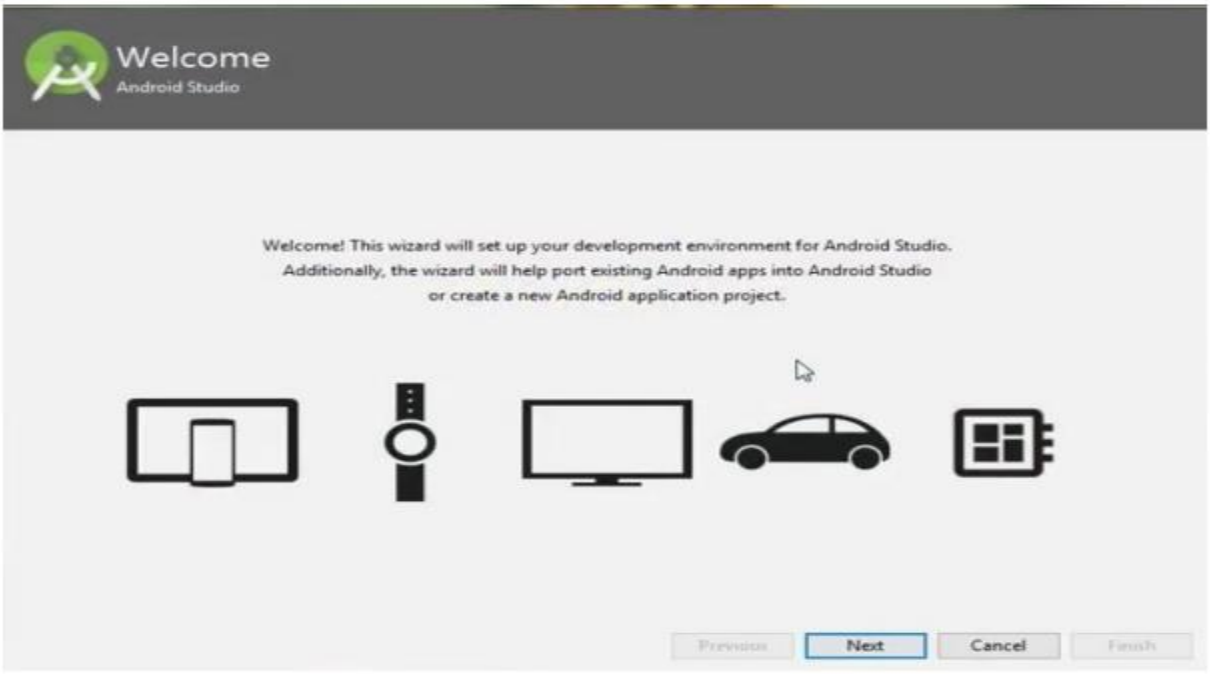
Step – 5: Once "Finish" is clicked, it will ask whether the previous settings needs to be imported [if android studio had been installed earlier], or not.

It is better to choose the 'Don't import Settings option'.

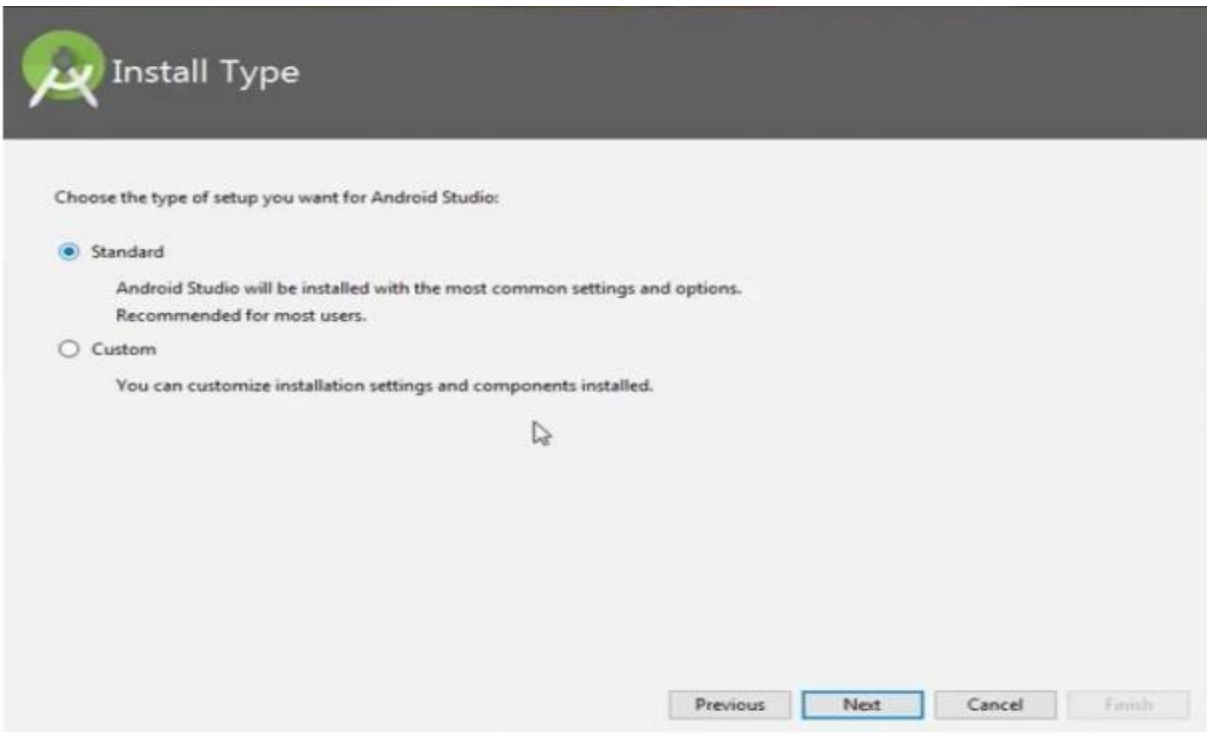
Step – 6 : This will start the Android Studio.

Meanwhile it will be finding the available SDK components.

Step – 7: After it has found the SDK components, it will redirect to the Welcome dialog box.



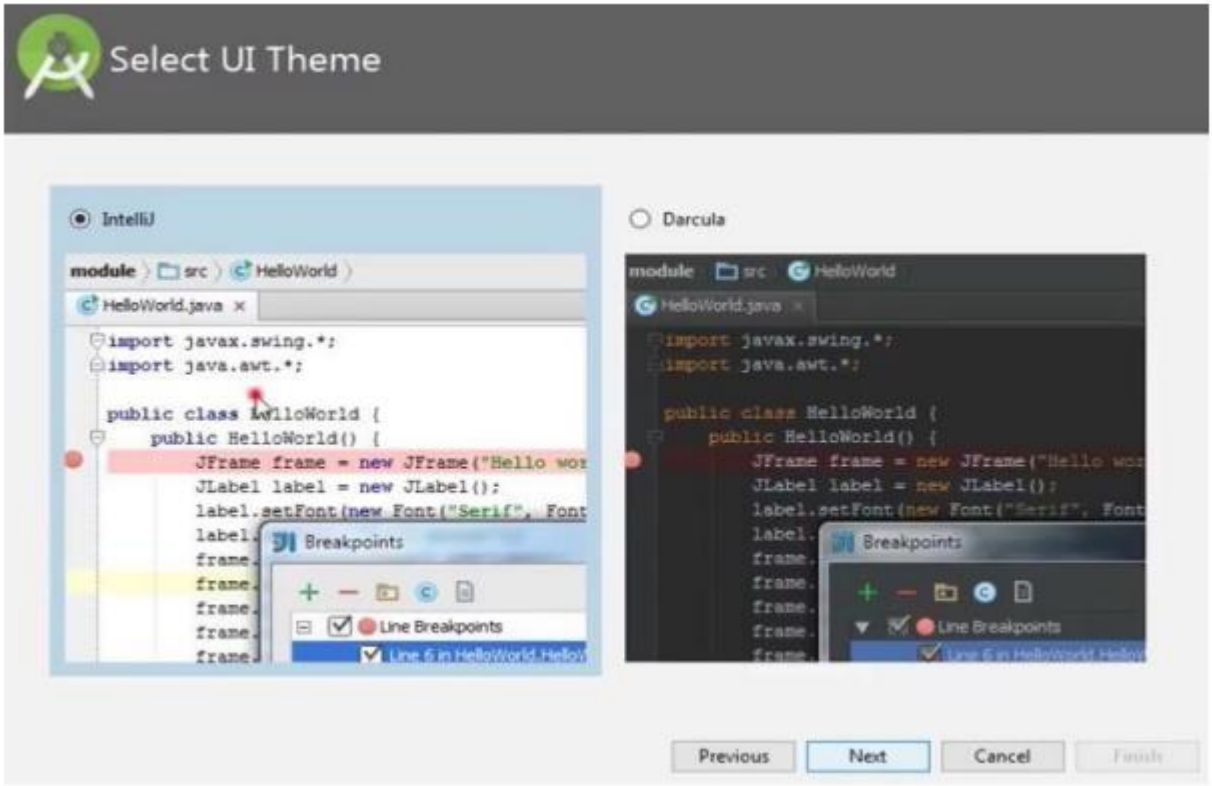
Click Next



Choose Standard and click on Next.

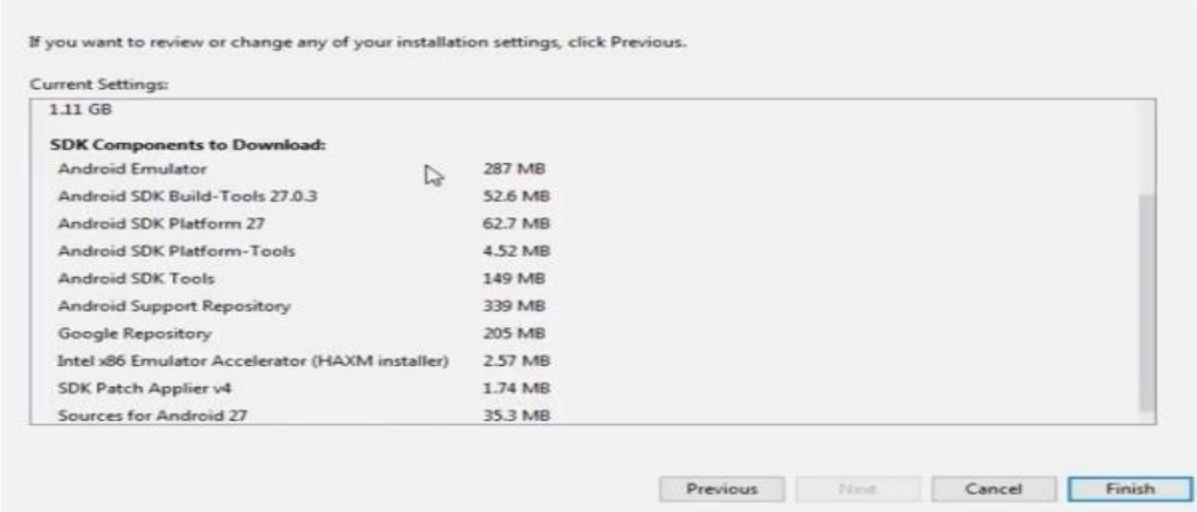
Now choose the theme, whether Light theme or the Dark one .

The light one is called the IntelliJ theme whereas the dark theme is called Darcula . Choose as required.



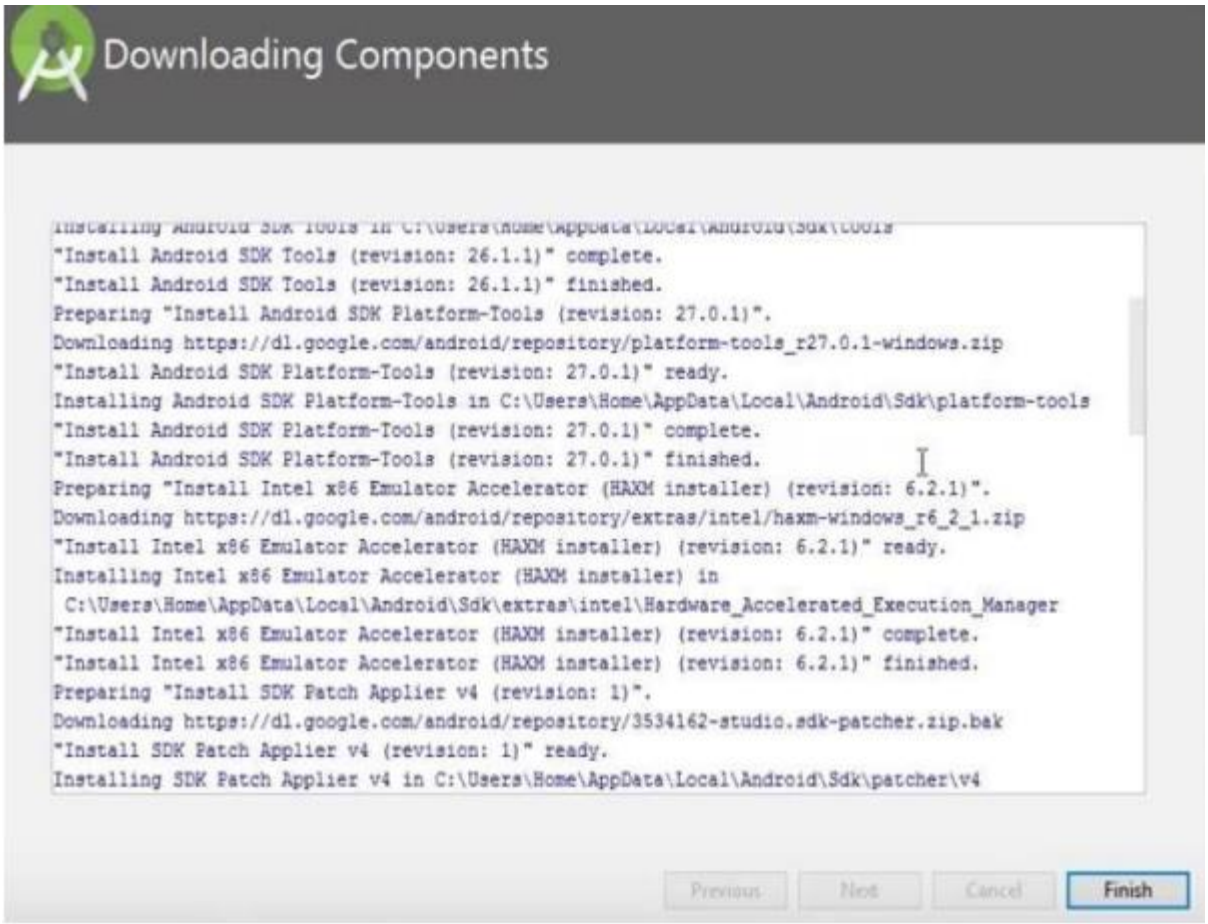
Click on the Next button

Step – 8 : Now it is time to download the SDK components.



Click on Finish.

It has started downloading the components



The Android Studio has been successfully configured. Now it’s time to launch and build app.

To create your new Android project, follow these steps:

• Install the latest version of Android Studio.

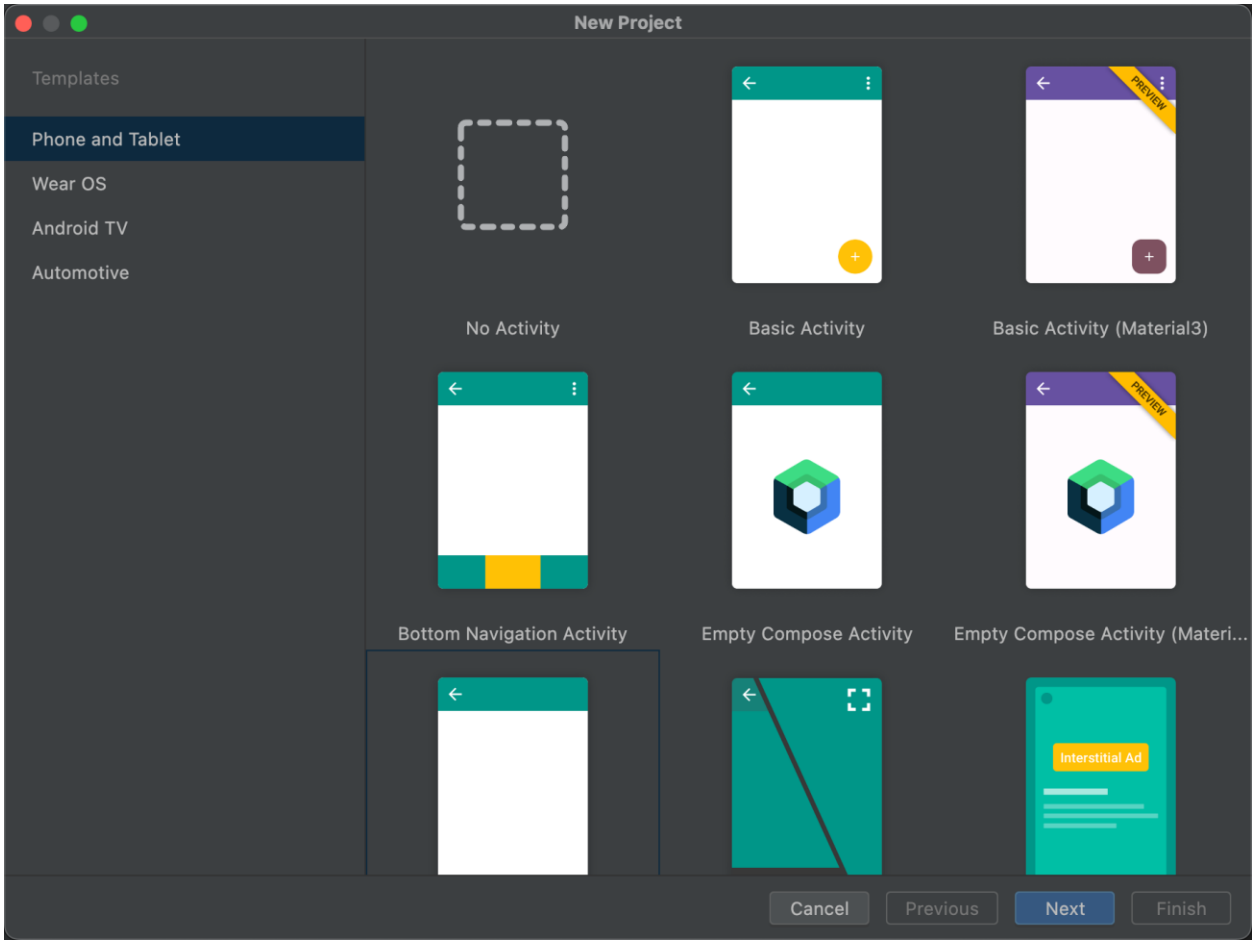
• In the Welcome to Android Studio window, click Start a new Android Studio project.

Creating a Project in Android and Launching Your First Android Application:

1. Create a new project by clicking **Start a new Android Studio project** on the Android Studio Welcome screen.
2. If you do have a project opened, create a new project by selecting **File > New > New Project** from the main menu.

Choose your project type

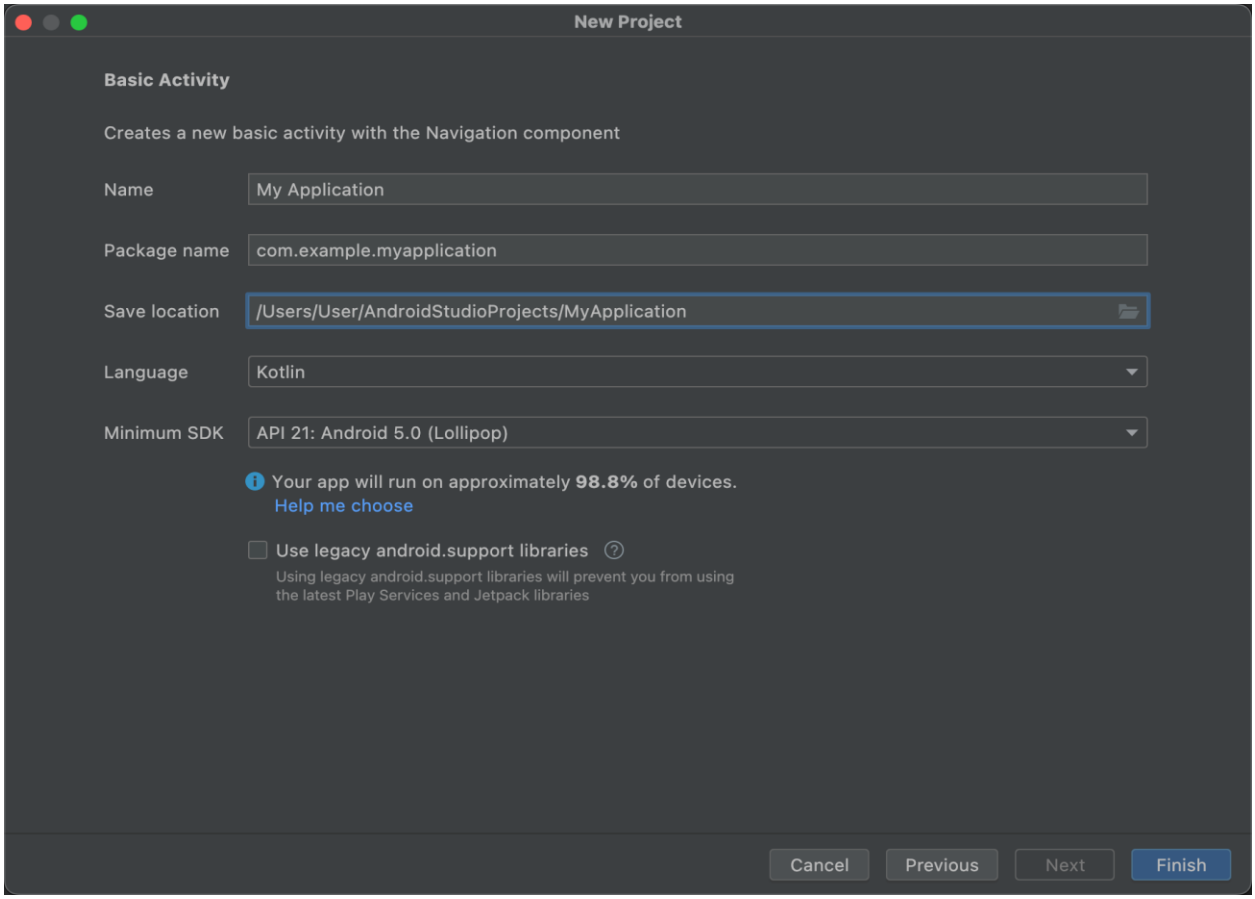
In the **New Project** screen that appears, you can select the type of project you want to create from categories of device form factors, shown in the **Templates** pane. For example, figure 1 shows the project templates for phone and tablet.



3. Selecting the type of project you want to create lets Android Studio include sample code and resources in your project to help you get started. Once you select your project type, click **Next**.

Configure your project

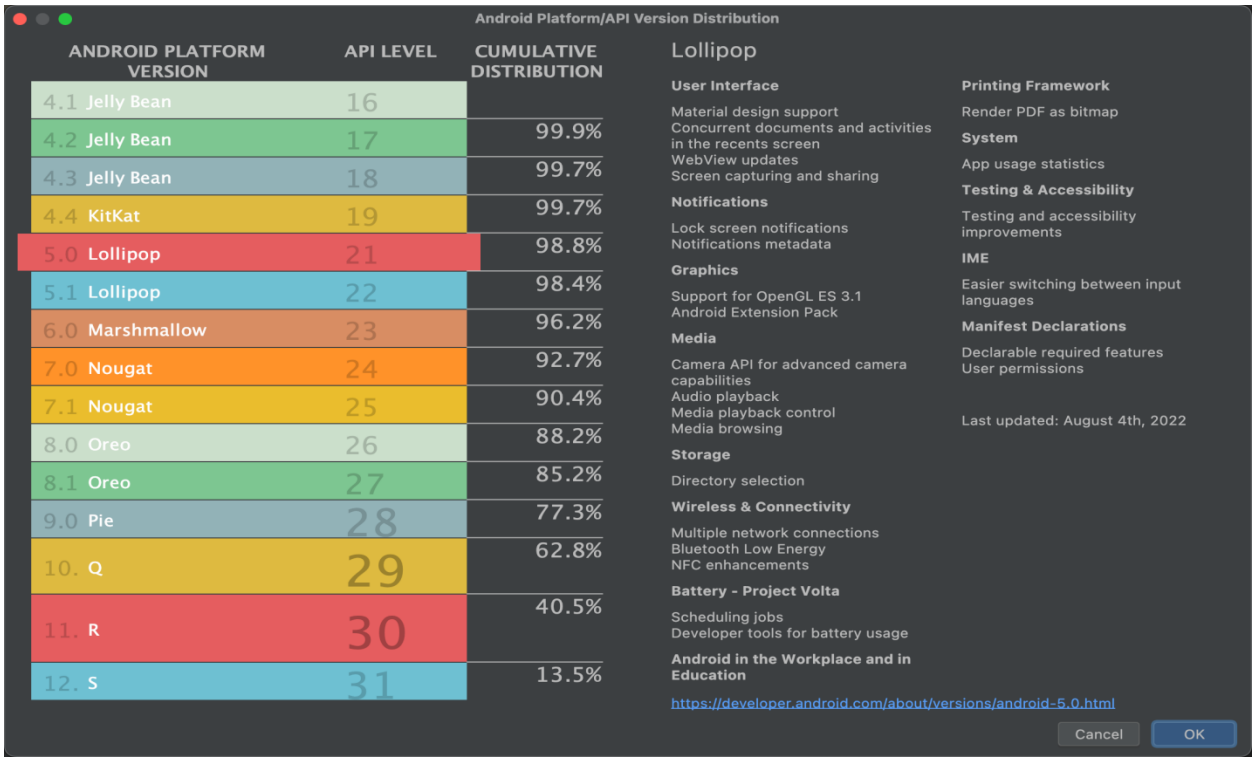
The next step in creating your project is to configure some settings, as shown in figure 2. If you're creating a **Native C++** project, read Create a new project with C/C++ support to learn more about the options you need to configure.



4. Specify the **Name** of your project. The **Name** field is used to enter the name of your project, for this codelab type "Greeting Card".
5. Specify the **Package name**. By default, this package name becomes your project's namespace (used to access your project resources) and your project's application ID (used as the ID for publishing). Leave the **Package name** field as is. This is how your files will be organized in the file structure. In this case, the package name will be `com.example.greetingcard`.
6. Specify the **Save location** where you want to locally store your project.
7. Select the **Language**, Kotlin or Java, you want Android Studio to use when creating sample code for your new project. Keep in mind that you aren't limited to using only that language in the project.
8. Select the **Minimum API level** you want your app to support. When you select a lower API level, your app can't use as many modern Android APIs. However, a larger percentage of Android devices can run your app. The opposite is true when selecting a higher API level. Select API 24: Android 7.0 (Nougat) from the menu

in the Minimum SDK field. Minimum SDK indicates the minimum version of Android that your app can run on.

9. If you want to see more data to help you decide, click **Help me choose**. This displays a dialog showing the cumulative distribution for the API level you have selected and lets you see the impact of using different minimum API levels.

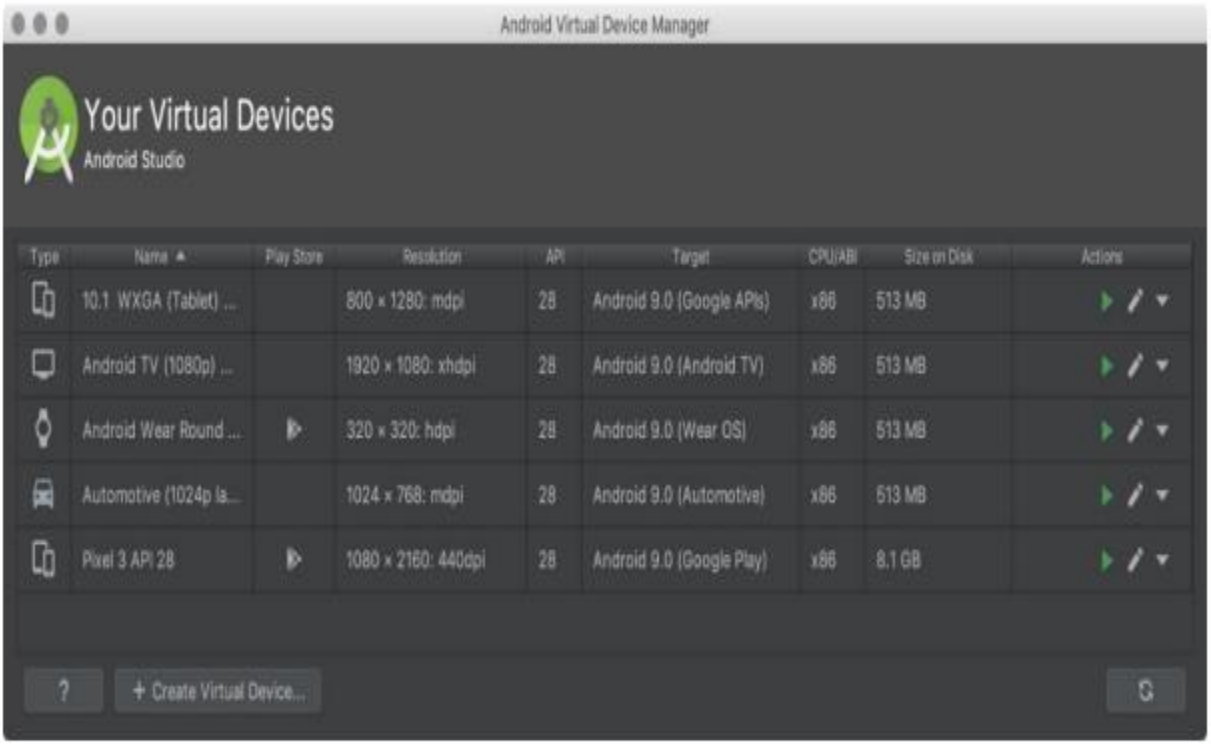


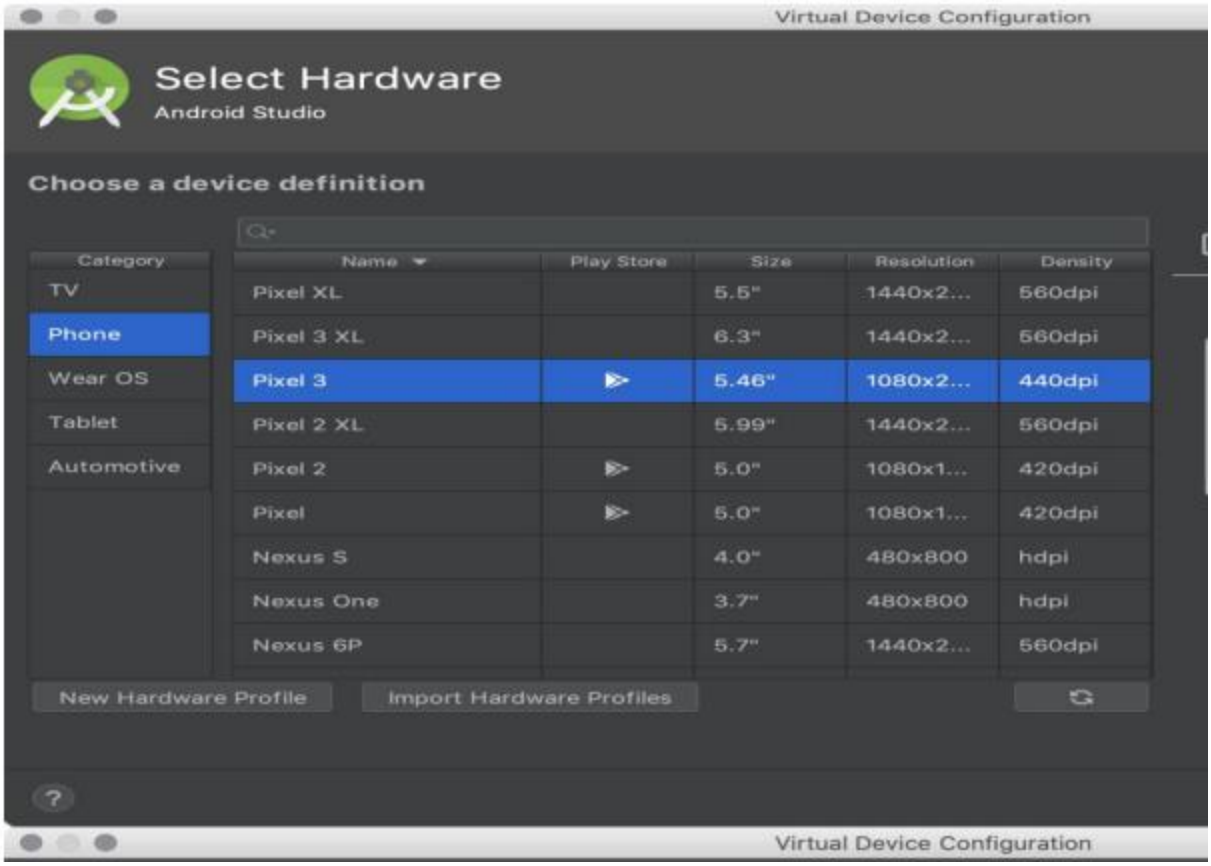
10. Your project is configured to use AndroidX libraries by default, which replace the Android Support libraries. To use the legacy support libraries instead, select **Use legacy android.support libraries**. However, this is not recommended, as the legacy support libraries are no longer supported. To learn more, read the AndroidX overview.
11. When you're ready to create your project, click **Finish**.
12. Android Studio creates your new project with some basic code and resources to get you started.
13. After some processing time, the Android Studio main window appears.

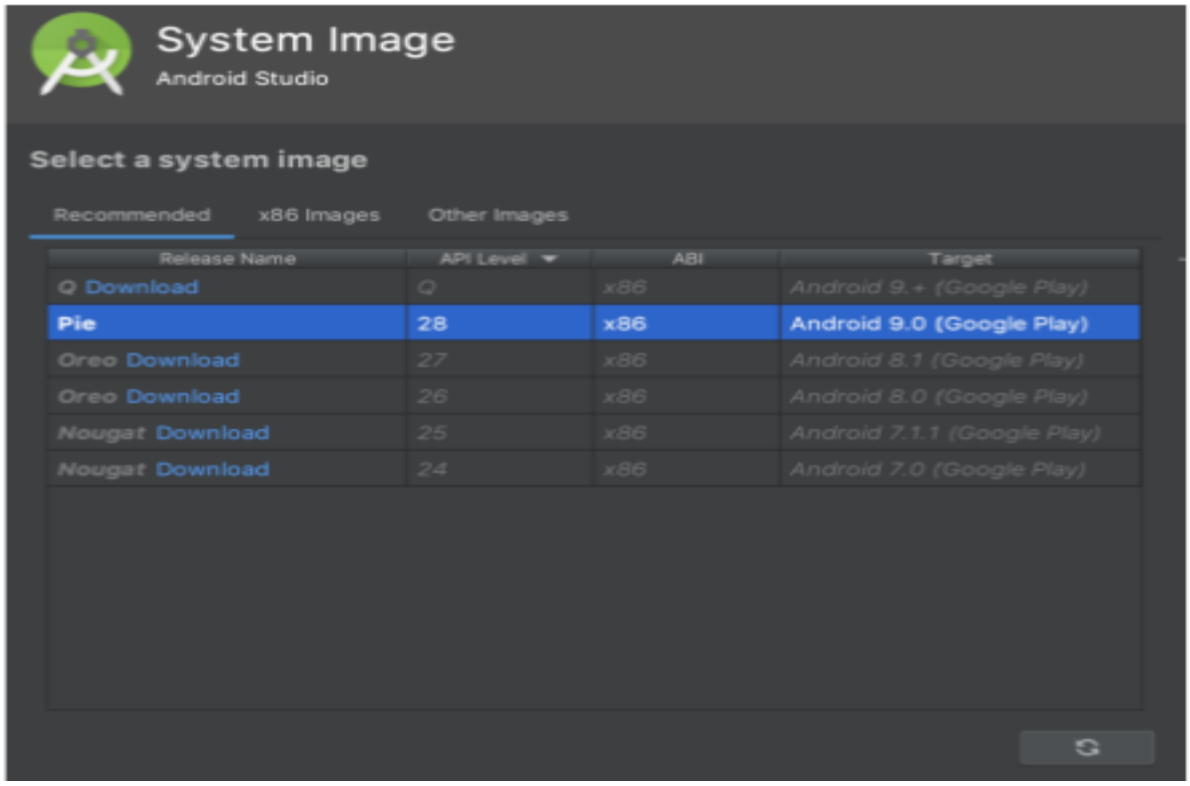
Creating AVD in Android Studio:

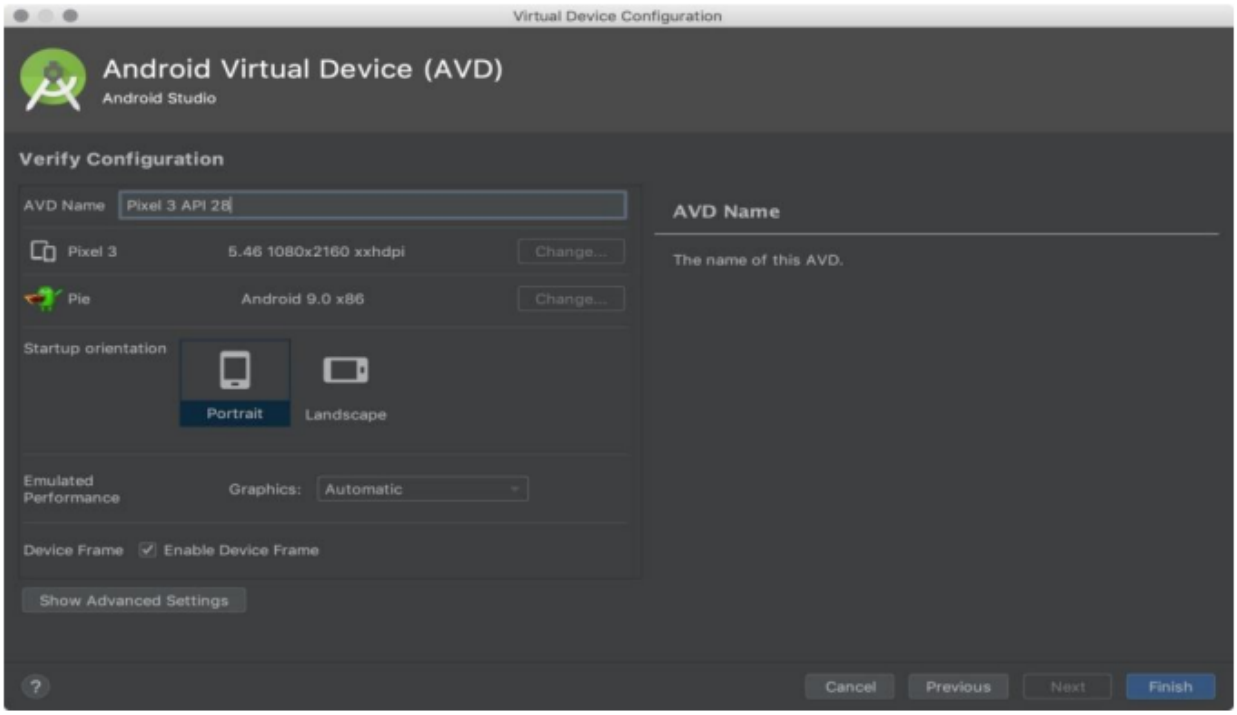
1. Open the AVD Manager by clicking Tools > AVD Manager.

2. Click Create Virtual Device, at the bottom of the AVD Manager dialog....
3. Select a hardware profile, and then click Next. Select the Nexus 5X API N (feel free to select the Nexus 5x API 18, which is the Jelly Bean emulator that you created in the Try It Out for the last section), and click Next.
4. Select the system image for a particular API level, and then click Next.
5. Change AVD properties as needed, and then click Finish




Virtual Device Configuration
Select Hardware
Android Studio
Choose a device definition
Category
TV
Phone
Wear OS
Tablet
Automotive
Name
Play Store
Size
Resolution
Density
Pixel XL 5.5" 1440x2... 560dpi
Pixel 3 XL 6.3" 1440x2... 560dpi
Pixel 3 5.46" 1080x2... 440dpi
Pixel 2 XL 5.99" 1440x2... 560dpi
Pixel 2 5.0" 1080x1... 420dpi
Pixel 5.0" 1080x1... 420dpi
Nexus S 4.0" 480x800 hdpi
Nexus One 3.7" 480x800 hdpi
Nexus 6P 5.7" 1440x2... 560dpi
New Hardware Profile
Import Hardware Profiles
Virtual Device Configuration


System Image
Android Studio
Select a system image
Recommended
x86 Images
Other Images
Release Name
API Level
ABI
Target
Q Download Q x86 Android 9.+ (Google Play)
Pie 28 x86 Android 9.0 (Google Play)
Oreo Download 27 x86 Android 8.1 (Google Play)
Oreo Download 26 x86 Android 8.0 (Google Play)
Nougat Download 25 x86 Android 7.1.1 (Google Play)
Nougat Download 24 x86 Android 7.0 (Google Play)



How to Run the Project:

1. After the project is created, there are 2 files, MainActivity.java and activity_main.xml
2. Go to activity_main.xml and select Design View
3. In Design View, change the layout to Linear Layout (Vertical) select Add Text View, and change the text to “Hello World!”
4. Click on Run and select the AVD already created (if not created, first create the AVD)
5. Output screen should show “Hello World”.