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A Research On Android Technology With New Version 14

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Abstract

Android 14 is the 64-bit fourteenth major release and the 21st version of Android, the mobile operating system developed by the Open Handset Alliance led by Google. It was released to the public and the Android Open Source Project (AOSP) on October 4, 2023. The first devices to ship with Android 14 are the Pixel 8 and Pixel 8 Pro. The beta versions are available for Pixel devices that are guaranteed Android version updates, the Pixel 4a (5G) or newer devices. Pixel 7a can also beta test Android 14 since Beta 3. The Pixel Tablet and Pixel Fold have been able to beta test Android 14 since Beta 4. Still, it gives us a broad glimpse at some of the themes and adjustments we can expect when the software's final version rolls around later this year.

Keywords- Operating system, mobile application, library, Linux Kernel, Dalvik virtual machine, memory, security, privacy, Android runtime

Introduction

This research has been done to give you the best details toward the exciting new features of open source mobile development. Android is the newest mobile device operating system, and this is one of the first research to help the average programmer become a fearless Android developer. Android is an open-source, Linux-based operating system for mobile devices such as smart phones and tablet computers. Android was founded by a company, named android Inc. in Palo Alto of California, U. S in 2003 whose founder was Andy Rubin, which was purchased by Google in 2005. The version history of the Android mobile operating system began with the release of the Android alpha in November 5, 2007. The first commercial version, Android 1.0, was released in September 2008. Android is continually developed by Google and the Open Handset Alliance(OHA), and it has seen a number of updates to its base operating system since the initial release. Versions 1.0 and 1.1 were not released under specific code names, but since 2009's Android 1.5 Cupcake. A version of Android KitKat exclusive to Android Wear devices was released on June 25, 2014, with an API level of 20. Each is in alphabetical order, with the most recent major version being Android 14 released in October 4, 2023.

Android Open Source Project

Android is a mobile operating system (32-bit and 64-bit) based on a modified version of the Linux kernel and other open-source software, designed primarily for touchscreen mobile devices such as smartphones and tablets. Android is developed by a consortium of developers known as the Open Handset Alliance, though its most widely used version is primarily developed by Google. It was unveiled in November 2007, with the first commercial Android device, the HTC Dream, being launched in September 2008.

[8] At its core, the operating system is known as the Android Open Source Project (AOSP) and is free and open-source software (FOSS) primarily licensed under the Apache License. However, most devices run on the proprietary Android version developed by Google, which ships with additional proprietary closed-source software pre-installed, most notably Google Mobile Services (GMS) which includes core apps such as Google Chrome, the digital distribution platform Google Play, and the associated Google Play Services development platform. Firebase Cloud Messaging is used for push notifications. While AOSP is free, the "Android" name and logo are trademarks of Google, which imposes standards to restrict the use of Android branding by "uncertified" devices outside their ecosystem

Android Architecture:

Software stack is split into four layers. That are

1. Application layer
2. Application Framework
3. Libraries
4. Linux kernel

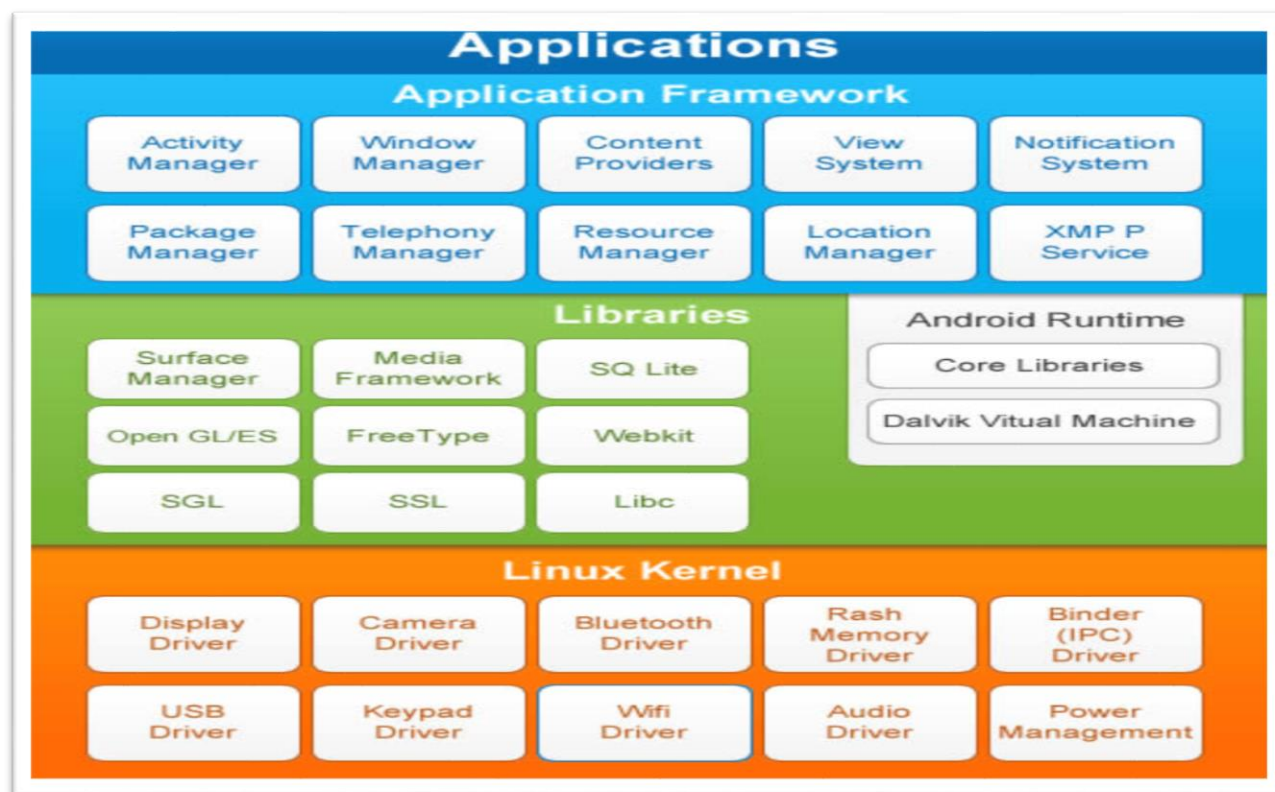


Fig 1. Architecture of Android Operating System

[11] In the Android architecture, the application layer is the outermost with core applications written in Java programming language such as contacts, email, and SMS, all of which can be run simultaneously. One can be reading an SMS and listening to music at the same time. The open-source design is reflected in replacing an application downloaded from the Google market or directly from the developer's site allowing the user to customize the mobile device

Android Version with History

Name	Android version/Name	Version number	Initial release date	API Level
Android 1.0	No Codename	1.0	September 23, 2008	1
Android 1.1	Petit Four	1.1	February 9, 2009	2
Android Cupcake	Cupcake	1.5	April 27, 2009	3
Android Donut	Donut	1.6	September 15, 2009	4
Android Eclair	Eclair	2.0	October 27, 2009	5
		2.0.1	December 3, 2009 ⁶	6
		2.1	January 11, 2010	7
Android Froyo	Froyo	2.2 – 2.2.3	May 20, 2010	8
Android Gingerbread	Gingerbread	2.3 – 2.3.2	December 6, 2010	9
		2.3.3 – 2.3.7	February 9, 2011	10
Android Honeycomb	Honeycomb	3.0	February 22, 2011	11
		3.1	May 10, 2011	12
		3.2 – 3.2.6	July 15, 2011	13
Android Ice Cream Sandwich	Ice Cream Sandwich	4.0 – 4.0.2	October 18, 2011	14
		4.0.3 – 4.0.4	December 16, 2011	15
Android Jelly Bean	Jelly Bean	4.1 – 4.1.2	July 9, 2012	16
		4.2 – 4.2.2	November 13, 2012	17
		4.3 – 4.3.1	July 24, 2013	18
Android KitKat	Key Lime Pie	4.4 – 4.4.4	October 31, 2013	19
		4.4W – 4.4W.2	June 25, 2014	20
Android Lollipop	Lemon Meringue Pie	5.0 – 5.0.2	November 4, 2014	21
		5.1 – 5.1.1	March 2, 2015	22
Android Marshmallow	Macadamia Nut Cookie	6.0 – 6.0.1	October 2, 2015	23
Android Nougat	New York Cheesecake	7.0	August 22, 2016	24
		7.1 – 7.1.2	October 4, 2016	25
Android Oreo	Oatmeal Cookie	8.0	August 21, 2017	26
		8.1	December 5, 2017	27
Android Pie	Pistachio Ice Cream	9	August 6, 2018	28
Android 10	Quince Tart ^l	10	September 3, 2019	29
Android 11	Red Velvet Cake	11	September 8, 2020	30
Android 12	Snow Cone	12	October 4, 2021	31
Android 12L	Snow Cone v2	12.1	March 7, 2022	32
Android 13	Tiramisu	13	August 15, 2022	33
Android 14	Upside Down Cake ^l	14	October 4, 2023	34
Android 15	Vanilla Ice Cream	15	Q3 2024	15

Table 1: Versions of Android Operating System

[10] Android 1.0(API 1):-Android 1.0, the first commercial version of the software, was released on September 23, 2008. The first commercially available Android device was the HTC Dream. Various features of this versions are following:

- Android Market allowed application downloads and updates through the Market application.
- Web browser to show, zoom and pan full HTML and XHTML web pages – multiple pages show as windows ("cards")
- Camera support – however, this version lacked the option to change the camera's resolution, white balance, quality, etc
- Folders allowing the grouping of a number of application icons into a single folder icon on the Home screen
- Access to web email servers, supporting POP3, IMAP4, and SMTP
- Gmail synchronization with the Gmail application.
- Google Contacts synchronization with the People application.
- Google Calendar synchronization with the Calendar application.
- Google Maps with Street View to view maps and satellite imagery, as well as find local businesses and obtain driving directions using GPS
- Google Sync, allowing management of over-the-air synchronization of Gmail, People, and Calendar.
- Google Search, allowing users to search the Internet and phone applications, contacts, calendar, etc.
- Google Talk instant messaging.
- Instant messaging, text messaging, and MMS.
- Media Player, enabling management, importing, and playback of media files – however, this version lacked video and stereo Bluetooth support
- Notifications appear in the Status bar, with options to set ringtone, LED or vibration alerts
- Voice Dialer allows dialing and placing of phone calls without typing a name or number
- Wallpaper allows the user to set the background image or photo behind the Home screen icons and widgets.
- YouTube video player
- Other applications include: Alarm Clock, Calculator, Dialer (Phone), Home screen (Launcher), Pictures (Gallery), and Settings.
- Wi-Fi and Bluetooth support.

Android 1.1 (API 2): - It developed on February 9, 2009, the Android 1.1 updated was released, initially for the HTC Dream only. There are some updated features are given below:

- Details and reviews available when a user searches for businesses on Maps.
- Longer in-call screen timeout by default when using the speakerphone, plus the ability to show/hide the dialpad.
- Ability to save attachments in messages.
- Support added for marquee in system layouts.

Android 1.5 Cupcake (API 3):- Android Cupcake is the third version of Android developed by Google, a major platform release deployable to Android-powered handsets starting in April 2009, that is no longer supported. It has various features which are given below:

- Support for third-party virtual keyboards with text prediction and a user dictionary for custom words.
- Animated screen transitions.
- Auto-rotation option.
- New stock boot animation.
- Ability to upload videos to YouTube.
- Ability to upload photos to Picasa.
- Ability to check phone usage history

Android 1.6 Donut (API 4):- Android "Donut" is the fourth version of the open source Android mobile operating system developed by Google that is no longer supported. Among the more prominent features introduced with this update were added support for CDMA smartphones, additional screen sizes, a battery usage indicator, and a text-to-speech engine. It developed on September 15, 2009. There are some features which are following:

- Voice and text entry search enhanced to include bookmark history, contacts, and the web.
- Ability for developers to include their content in search results.
- Multi-lingual speech synthesis engine to allow any Android application to "speak" a string of text.
- Easier searching and the ability to view app screenshots in Android Market.
- Gallery, Camera and camcorder more fully integrated, with faster camera access.

Android 2.0 Éclair(API 5):-Android "Eclair" is a codename of the Android mobile operating system developed by Google and the fifth operating system for Android, and for the no-longer supported versions 2.0 to 2.1. Unveiled on October 26, 2009, Android 2.1 builds upon the significant changes made in Android 1.6 "Donut".

- Expanded Account sync, allowing users to add multiple accounts to a device for synchronization of an email and contacts.
- Microsoft Exchange email support, with a combined inbox to browse an email from multiple accounts in one page.
- Bluetooth 2.1 support.
- Ability to tap a Contacts photo and select to call, SMS, or email the person.
- Ability to search all saved SMS and MMS messages, with the added ability to delete the oldest messages in a conversation automatically deleted when a defined limit is reached.
- Numerous new camera features, including flash support, digital zoom, scene mode, white balance, color effect and macro focus.
- Improved typing speed on a virtual keyboard, with a smarter dictionary that learns from word usage and includes contact names as suggestions.
- Refreshed browser UI with bookmark thumbnails, double-tap zoom and support for HTML5.
- Calendar agenda view enhanced, showing attending status for each invitee, and the ability to invite new guests to events.

Android 2.2 Froyo(API 6):-Android "Froyo" is the next version of Android and is a codename of the Android mobile operating system developed by Google, spanning versions between 2.2 and 2.2.3. Those versions are no longer supported. It was unveiled on May 20, 2010, during the Google I/O 2010 conference. New features introduced by Froyo include the following:

- Speed, memory, and performance optimization ^[4]
- Additional application speed improvements, implemented through JIT compilation.^[3]
- Integration of Chrome's V8 JavaScript engine into the Browser application.
- Support for the Android Cloud to Device Messaging (C2DM) service, enabling push notifications.
- Improved Microsoft Exchange support, including security policies, auto-discovery, GAL look-up, calendar synchronization and remote wipe.
- Improved application launcher with shortcuts to Phone and Browser applications.
- USB tethering and Wi-Fi hotspot functionality.^[2]
- Option to disable data access over a mobile network.
- Updated Market application with batch and automatic update features.
- Quick switching between multiple keyboard languages and their dictionaries.

Android 2.3 Gingerbread (API 9 - 10):-Android 2.3 "Gingerbread" is the next version of Android, a codename of the Android mobile operating system developed by Google and released in December 2010, for versions that are no longer supported. The Gingerbread release introduced support for near field communication (NFC)—used in mobile payment solutions—and Session Initiation Protocol (SIP)—used in VoIP internet telephones. The various new features are:

- Updated user interface design, providing increased ease-of-use and efficiency.
- Support for extra-large screen sizes and resolutions (WXGA and higher).
- Native support for SIP VoIP internet telephones.
- Improved text input using the virtual keyboard, with improved accuracy, better text suggestions, and voice input capability.
- Enhanced copy/paste functionality, allowing users to select a word by press-holding, copying, and pasting.
- Support for Near Field Communication (NFC), allowing the user to read NFC tags embedded in posters, stickers, or advertisements.
- New audio effects such as reverb, equalization, headphone virtualization, and bass boost.
- New Download Manager, giving users easy access to any file downloaded from the browser, email, or another application.
- Enhanced support for native code development.
- A switch from YAFFS to ext4 file system on newer devices.
- Audio, graphical, and input enhancements for game developers.
- Concurrent garbage collection for increased performance.
- Native support for more sensors (such as gyroscopes and barometers).
- Added Easter Egg following a zombie gingerbread and another normal-type zombies (normal zombies all using phones)

Android 3.0 Honeycomb (API 11-13):-Android "Honeycomb" is the codename for the next version of Android, designed for devices with larger screen sizes, particularly tablets. It is no longer supported. Honeycomb debuted with the Motorola Xoom in February 2011. Besides the addition of new features, Honeycomb introduced a new so-called "holographic" user interface theme and an interaction model that built on the main features of Android, such as multitasking, notifications and widgets. New features of this versions are given below:

- The Email and Contacts apps use a two-pane UI.
- The Gallery app now lets users view albums and other collections in full-screen mode, with access to thumbnails for other photos in a collection.
- The Browser app replaces browser windows with tabs, adds an incognito mode for anonymous browsing, and presents bookmarks and history in a unified view, among other features.
- A redesigned keyboard to make entering text easier on large-screen devices such as tablets.
- A Recent Apps view for multitasking.
- Customizable home screens (up to five).

Android 4.0 Ice Cream Sandwich (API 14):-Android "Ice Cream Sandwich" is the fourth version of the Android mobile operating system developed by Google. Unveiled on October 19, 2011, Android 4.0 builds upon the significant changes made by the tablet-only release Android Honeycomb, in an effort to create a unified platform for both smartphones and tablets. There some new features are given below:

- Major refinements to the "Holo" interface with the new Roboto font family.
- Soft buttons from Android 3.x are now available for use on phones.
- Separation of widgets in a new tab, listed in a similar manner to applications.
- Easier-to-create folders, with a drag-and-drop style.
- Improved visual voicemail with the ability to speed up or slow down voicemail messages.
- Pinch-to-zoom functionality in the Calendar.
- Integrated screenshot capture (accomplished by holding down the Power and Volume-Down buttons).
- Improved error correction on the keyboard.
- Ability to access applications directly from the lock screen.
- Improved copy-and-paste functionality.
- Better voice integration and continuous, real-time speech-to-text dictation.
- Face Unlock, a feature that allows users to unlock handsets using facial recognition software.^[80]

Android 4.1 Jelly Bean (API 16-18) :-Google announced Android 4.1 (Jelly Bean) at the Google I/O conference on June 27, 2012. Based on Linux kernel 3.0.31, Jelly Bean was an incremental update with the primary aim of improving the functionality and performance of the user interface. The performance improvement involved "Project Butter", which uses touch anticipation, triple buffering, extended vsync timing and a fixed frame rate of 60 fps to create a fluid and "buttery-smooth" UI. Android 4.1 Jelly Bean was released to the Android Open Source Project on July 9, 2012, and the Nexus 7 tablet, the first device to run Jelly Bean, was released on July 13, 2012. There are some features:

- Smoother user interface:
 - Vsync timing across all drawing and animation done by the Android framework, including application rendering, touch events, screen composition and display refresh.
 - Triple buffering in the graphics pipeline.
 - CPU input boost.
 - Synchronizing touch to vsync timing.
- Enhanced accessibility.
- Bi-directional text and other language support.
- User-installable keyboard maps.
- Expandable notifications.
- Ability to turn off notifications on an application-specific basis.
- Shortcuts and widgets can automatically be re-arranged or re-sized to allow new items to fit on home screens.
- Bluetooth data transfer for Android Beam.
- Tablets with smaller screens now use an expanded version of the interface layout and home screen used by phones.
- Improved camera application.
- Multichannel audio.
- The Fraunhofer FDK AAC codec becomes standard in Android, adding AAC 5.1 channel encoding/decoding.
- USB audio (for external sound DACs).
- Audio chaining (also known as gapless playback).
- Ability for other launchers to add widgets from the application drawer without requiring root access.
- Lock/home screen rotation support.
- One-finger gestures to expand/collapse notifications.
- Bug fixes and performance enhancements.

Android 4.4 KitKat(API 19):- Google announced Android 4.4 KitKat on September 3, 2013. Although initially under the "Key Lime Pie" ("KLP") codename, the name was changed because "very few people actually know the taste of a key lime pie." Some technology bloggers also expected the "Key Lime Pie" release to be Android 5.[44] KitKat debuted on Google's Nexus 5 on October 31, 2013, and was optimized to run on a greater range of devices than earlier Android versions, having 512 MB of RAM as a recommended minimum; those improvements were known as "Project Svelte" internally at Google. The required minimum amount of RAM available to Android is 340 MB, and all devices with less than 512 MB of RAM must report themselves as "low RAM" devices. There are some features:-

- Refreshed interface with white elements instead of blue.
- Clock no longer shows bold hours; all digits are thin. The H, M, and S markings for the stopwatch and timer have been removed, leaving just the numbers.
- Ability for applications to trigger translucency in the navigation and status bars.
- Ability for applications to use "immersive mode" to keep the navigation and status bars hidden while maintaining user interaction.
- Action overflow menu buttons are always visible, even on devices with a "Menu" key, which was officially deprecated by Android 4.0.

- Restriction for applications when accessing external storage, except for their own directories.
- Optimizations for performance on devices with lower specifications, including zRAM support and "low RAM" device API.
- Wireless printing capability.
- NFC host card emulation, enabling a device to replace smart cards.
- WebViews are now based on the Chromium engine (feature parity with Chrome for Android 30).
- Expanded functionality for notification listener services.
- Public API for developing and managing text messaging clients.
- Native infrared blaster API.
- Verified boot.
- Enforcing SELinux.
- Expanded accessibility APIs and system-level closed captioning settings.
- Android Runtime (ART) introduced as a new experimental application runtime environment, not enabled by default, as a replacement for the Dalvik virtual machine.
- Bluetooth Message Access Profile (MAP) support.
- Disables text wrapping in the WebView browser component.

Android 5.1 Lollipop (API 22) :- Android 5.0 "Lollipop" was unveiled under the codename "Android L" on June 25, 2014, during Google I/O. It became available as an official over-the-air (OTA) update on November 12, 2014, for select devices that run distributions of Android serviced by Google, including Nexus and Google Play edition devices. Its source code was made available on November 3, 2014. Lollipop features a redesigned user interface built around a responsive design language referred to as "material design". Other changes include improvements to the notifications, which can be accessed from the lockscreen and displayed within applications as top-of-the-screen banners. Furthermore, Google made internal changes to the platform, with the Android Runtime (ART) officially replacing Dalvik for improved application performance, and with changes intended to improve and optimize battery usage, known internally as Project Volta. There are some features:-

- Android Runtime (ART) with ahead-of-time (AOT) compilation and improved garbage collection (GC), replacing Dalvik that combines bytecode interpretation with trace-based just-in-time (JIT) compilation.^{[174][176]}
- Support for 64-bit CPUs.
- OpenGL ES 3.1 and Android Extension Pack (AEP) on supported GPU configurations.
- Recent activities screen with tasks instead of applications, up to a configured maximum of tasks per application.
- Vector drawables, which scale without losing definition.
- Support for print previews.
- Updated emoji.
- Improved accessibility support (e.g. switch access support).
- Block-based over-the-air (OTA) updates for new devices
- Improvements and bug fixes to the Overview screen.
- Ability to join Wi-Fi networks and control paired Bluetooth devices from quick settings.
- Official support for multiple SIM cards.
- Device protection: if a device is lost or stolen it will remain locked until the owner signs into their Google account, even if the device is reset to factory settings.
- High-definition voice calls, available between compatible 4G LTE devices running Android 5.1.^[194]
- Improvements to the notification priority system, to more closely replicate the silent mode that was removed from Android 5.0

Android 6.0 Marshmallow (API 23) :- Android 6.0 "Marshmallow" was unveiled under the codename "Android M" during Google I/O on May 28, 2015, for the Nexus 5 and Nexus 6 phones, Nexus 9 tablet, and Nexus Player set-top box, under the build number MPZ44Q. The third developer preview (MPA44G) was released on August 17, 2015 for the Nexus 5, Nexus 6, Nexus 9 and Nexus Player devices,^[199] and was updated to MPA44I that brought fixes related to Android for Work profiles. Some features are given below:-

- Contextual search from keywords within apps.
- Introduction of Doze mode, which reduces CPU speed while the screen is off in order to save battery life.
- App Standby feature.
- Alphabetically accessible vertical application drawer.
- Application search bar and favorites.
- Native fingerprint reader support.
- Direct Share feature for target-specific sharing between apps.
- MIDI support for musical instruments.
- Experimental multi-window feature.
- Support for actions by third-party apps in the text selection menu.
- App permissions now granted individually at run-time, not all-or-nothing at install time. Similar to App Ops.
- Miracast support dropped.
- Many new essential commands supported by Android's Linux shell (/bin/sh).
- No screen rotation during touch.

Android 7.0 Nougat (API 24):-Android "Nougat" (codenamed N in-development) is the major 7.0 release of the Android operating system. It was first released as a developer preview on March 9, 2016, with factory images for current Nexus devices, as well as with the new "Android Beta Program" which allows supported devices to be upgraded directly to the Android Nougat beta via an over-the-air update. The final release was on August 22, 2016. The final preview build was released on July 18, 2016, with the build number NPD90G. Some features are given below:

- Support for file-based encryption.
- Unicode 9.0 emoji and skin tone modifier support (and exposes a subset of ICU4J APIs).
- Ability to display color calibration.
- Ability to zoom in the screen.
- Ability to switch to the last opened app by double-tapping the overview button.
- Added an Emergency information part.
- Added the "Clear All" button to the Overview screen.
- Another system partition, which gets updated when not in use, allowing for seamless system updates.
- Daydream virtual reality platform (VR interface).
- Improved Doze functionality, which aims to prolong battery life.
- Improvements to the file browser.
- More Quick Settings options.
- Multi-window support, which supports floating apps on a desktop layout.
- New Data Saver mode, which can force apps to reduce bandwidth usage.
- New JIT Compiler, making for 75 percent faster app installations and a 50 percent reduction in compiled code size.
- Just in Time (JIT) compiler with code profiling to ART, which lets it constantly improve the performance of Android apps as they run.
- Picture-in-picture support for Android TV.
- Redesigned notification shade, featuring instant access to certain settings.
- Redesigned Overview screen.
- Replaced notification cards with notification sheets.
- Settings app navigation drawer.
- Vulkan 3D rendering API.
- Multiple Device Locales.

Android 8.0 Oreo (API 26):- Android "Oreo" (codenamed Android O during development) is the eighth major release and the 15th version of the Android mobile operating system. It was first released as an alpha quality developer preview in March 2017 and released to the public on August 21, 2017. There are some features given below:

- Project Treble, the biggest change to the foundations of Android to date: a modular architecture that makes it easier and faster for hardware makers to deliver Android updates.
- Picture-in-picture support.
- Support for Unicode 10.0 emoji (5.0) and replacement of all blob-shaped emoji's by round ones with gradients and outlines.
- Redesigned Quick Settings and Settings with a white background and respectively black and Accent font colors.
- Restructured Settings by regrouping sections into similar entries.
- Adaptive icons.
- Notification improvements.
 - Notification channels.
 - Notification dots (badges).
 - Notification snoozing.
 - Notification shade multi-colors (for music album art, messengers, etc.).
- System-wide Autofill framework.
- Support for AAC, Sony's LDAC and Qualcomm's aptX and aptX HD codecs.^[229]
- App-specific unknown sources.
- Multi-display support.
- 2 times faster boot time compared to Nougat according to Google, testing on their Pixel devices.^[228]
- Apps background execution and location limits.
- Google Play Protect.
- Downloadable fonts.
- Integrated printing support.
- Color management (deep color and wide color gamut).
- Wi-Fi Assistant.

Android 9 Pie (API 28):- Android Pie is the ninth major version of the Android operating system. It was first announced by Google on March 7, 2018, and the first developer preview was released on the same day. The second preview, considered beta quality, was released on May 8, 2018. The final beta of Android Pie (fifth preview, also considered as a "Release Candidate") was released on July 25, 2018. The first official release was released on August 6, 2018. Some features are given below:

- New user interface for the quick settings menu.
- The clock has moved to the left of the notification bar.
- The "dock" now has a semi-transparent background.
- Battery Saver no longer shows an orange overlay on the notification and status bars.
- A "screenshot" button has been added to the power options.
- A new "Lockdown" mode which disables biometric authentication once activated.
- Rounded corners across the UI.
- New transitions for switching between apps, or activities within apps.
- Richer messaging notifications, where a full conversation can be seen within a notification, full-scale images, and smart replies akin to Google's new app, Reply.
- Support for display cutouts.
- Redesigned volume slider.
- Battery percentage now shown in Always-On Display.
- Lock screen security changes include the possible return of an improved NFC Unlock.
- Experimental features (which are currently hidden within a menu called Feature Flags) such as a redesigned About Phone page in settings, and automatic Bluetooth enabling while driving.

- DNS over TLS
- A new optional gesture-based system interface, allowing users to navigate the OS using swipes more often than the traditional UI.
- Redesigned multitask app switcher with the Google search bar and app drawer built-in.
- Android Dashboard, which tells the user how much time they are spending on their device and in apps, and allows the user to set time limits on apps.

Android 10 (API 29):- Android 10 is the tenth major version of the Android operating system. It was first announced by Google on March 13, 2019, and the first beta was released on the same day (under the name "Android Q" at the time). The second beta was released on April 3, 2019. The third beta was released at the Google I/O conference on May 7, 2019. Then, on June 5, Google released the fourth beta, with the finalized APIs and SDK (API Level 29). On July 10, 2019, Google released Beta 5 with the final API 29 SDK as well as the latest optimizations and bug fixes. This is the release candidate for testing. On August 7, 2019, Google released Beta 6, which was the last beta before the announcement of Android Q. On August 22, 2019, Google announced that the official release version would be called just Android 10 dropping the convention of using letter and dessert nicknames publicly. Android 10 was going to be known as "Queen Cake". Internally, Android 10 is known as Quince Tart. The stable version of Android 10 was released on September 3, 2019. Some features are given below:

- New permissions to access location in background and to access photo, video and audio files.
- Background apps can no longer jump into the foreground.
- Limited access to non-resettable device identifiers.
- Sharing shortcuts, which allow sharing content with a contact directly.
- Floating settings panel, that allows changing system settings directly from apps.
- Dynamic depth format for photos, which allow changing background blur after taking a photo.
- Support for the AV1 video codec, the HDR10+ video format and the Opus audio codec.
- Support for aptX Adaptive, LHDC, LLAC, CELT and AAC LATM codecs
- A native MIDI API, allowing interaction with music controllers.
- Better support for biometric authentication in apps.
- Support for the WPA3 Wi-Fi security protocol.
- Support for foldable phones.
- Support for Notification Bubbles.
- New system-wide dark theme/mode
- Project Mainline, allows core OS components to be updated via the Google Play Store, without requiring a complete system update

Android 11 (API 30):- Android 11 is the upcoming eleventh major release and the 18th version of the Android mobile operating system, due for release in Q3 2020. Alphabetical release names for major Android versions were discontinued as of Android 10; therefore the OS was immediately branded as "Android 11". The logo for the release features a dial turned to 11— a reference to the music documentary film This Is Spinal Tap.

Android 11 will have almost 100 new features

- Chat bubbles.
- Screen recorder.
- Notification history.
- New permissions controls.
- API distinction between standalone 5G NR and non-standalone 5G.
- One-time permissions.
- Permissions auto-reset.
- Wireless Android Auto on devices with 5GHz Wi-Fi.
- Increased number of updatable core OS components in Google Play from 12 to 21.
- Enterprise work profile privacy protections now apply on company-owned devices.
- Independent left and right edge sensitivity for gesture navigation

Android 12 (API 31)

Android 12 is the twelfth major version of the Android operating system. [7] It was first announced by Google on February 18, 2021, and the first developer preview was released on the same day. With Android 12, the UI takes up a bluish tint visible in both light and dark themes. Unlike the leaked Android 12 screenshots that suggested that the UI adapt to the background with custom colors, we don't see any option upfront to change this color. We will be exploring the Developer options to see if we can find something similar. Some features are given below: -

- Easier Wi-Fi sharing.
- AVIF image support.
- Material You, an updated design language based on Material Design.
- Scrolling Screenshot.
- One Handed Mode.
- Android Runtime (ART) module added to the updatable core OS components via Google Play, added functionality to existing modules.
- Area Magnification can zoom in any content on device.
- Extra Dim is a faint level of brightness not accessible by the brightness scale.
- Bold Text.
- Greyscale.
- Mic and Camera indicator and toggle.
- Option to choose precise or approximate location.
- Privacy Dashboard.
- Gestures can work in immersive mode.
- Performance improvements to system services to improve transitions, power efficiency, and reduce app startup times.
- Third party app stores now have the ability to update apps without constantly asking the user for permission.

Android 12L (API 32)

Android 12L is an interim release for Android 12 that includes design tweaks for larger displays and minor stability changes to the operating system. It was announced on October 2021 alongside Beta releases with a stable version launching on March 7, 2022.

Features: -

- Improvements specific for foldable phones, tablets, desktop-sized screens and Chromebooks, and modifications to the user interface to tailor it to larger screens.

Android 13 (API 33)

Android 13 was announced in an Android blog posted on February 10, 2022, and the first Developer Preview was immediately released for the Google Pixel series (from Pixel 4 to Pixel 6, dropping support for the Pixel 3 and Pixel 3a). It was released 4 months or so after the stable version of Android 12. Developer Preview 2 followed later, releasing in March. Beta 1 was released on April 26, 2022. Google released beta 2 during Google I/O on May 11, 2022. Two more beta versions were planned for release in June and July. Platform stability was reached in June, with Beta 3. The final release of Android 13 began on August 15 when the update was made available to Pixel phones and pushed to the Android Open Source Project. Features given below: -

- Apps are now required to request permission from the user before they are able to send notifications.
- The number of active apps is now shown at the bottom of the notifications panel, a tap on it opens a detailed panel which lets the user stop each of them.
- Support for Bluetooth LE Audio and the LC3 audio codec.
- ART update with a new garbage collector utilizing the Linux user fault fd system call. It reduces memory pressure, compiled code size, jank and prevents the risk of killing apps because of low memory during garbage collection. Other changes also improve app startup, reduce jank and improve performance. Because of the Mainline project, Android 12 ART will also be updated.
- Support of Themed icons by third-party apps and manufacturers.

Android 14 (API 34)

Android 14 was announced on February 8, 2023. A developer preview was released immediately as well as a roadmap with the dates of updates. This contained another developer preview, which was published on March 8, as well as four monthly beta versions. The first beta was released on April 12, which received a hotfix to Beta 1.1 on April 26. The second beta was released on May 10, which also received a hotfix to Beta 2.1 on May 25. The third beta version was released on June 7, now reaching platform stability, which later received a hotfix to Beta 3.1 on June 14. The fourth beta version was released on July 11. Android 14 had 1 year, 1 month, 2 weeks and 5 days between Android 13's Aug 15 2022 release, surpassing the Android 9 - 10 duration of 1 year and 4 weeks. The beta versions are available for Pixel devices that are guaranteed Android version updates, the Pixel 4a (5G) or newer devices. Pixel 7a can also beta test Android 14 since Beta 3. The Pixel Tablet and Pixel Fold have been able to beta test Android 14 since Beta 4. Features given below: -

- Installation of apps designed to target Android versions and SDKs older than Marshmallow (6.0) is blocked to prevent malware

Android version distribution / usages.

[9] Distribution of Android OS versions in Jan.-Dec-2023 in India shown below. By this picture we know that the most widely distributed version is Android 11 (KitKat), another one is Android 12. Charts in this section provide breakdowns of Android versions in India from Jan-Dec-2023. Android is the most popular operating system in the world, with over 2.5 billion active users spanning over 190 countries. Android is the dominant platform in most countries, although it has had trouble surpassing Apple in Japan and the United States. In countries like Brazil, India, Indonesia, Iran and Turkey, it has over 85 percent market share.

Mobil & tablet Android version market share in India from Jan - Dec 2023	
Android Version	Market Share %
11	23.7
12	22.88
13	20.05
10	15.18
9.0 Pie	7.61
8.1 Oreo	5.19
8.0 Oreo	1.34
6.0 Marshmallow	1.29
7.1 Nougat	0.89
7.0 Nougat	0.85
5.1 Lollipop	0.83
14	0.1
4.4 KitKat	0.04
5.0 Lollipop	0.03
Other	0.02

Table 2. Distribution / usage of Android OS in India (Jan-Dec.-2023)

Explore the latest trends and insights on the dominant Android operating system with up-to-date statistics.

- There are 3.3 billion Android OS users in the world as of 2023.
- Android has a 71.8% mobile operating systems' market share globally.
- Android 12.0.0_r46 (SSV1.210916.062) is the latest version of Android OS which was released on April 10, 2023.
- Samsung owns more than 34% share of the Android market.
- 1.57 billion Android devices were sold in 2022.
- 96.9% of apps available on the Android app store (Google play store) are free.

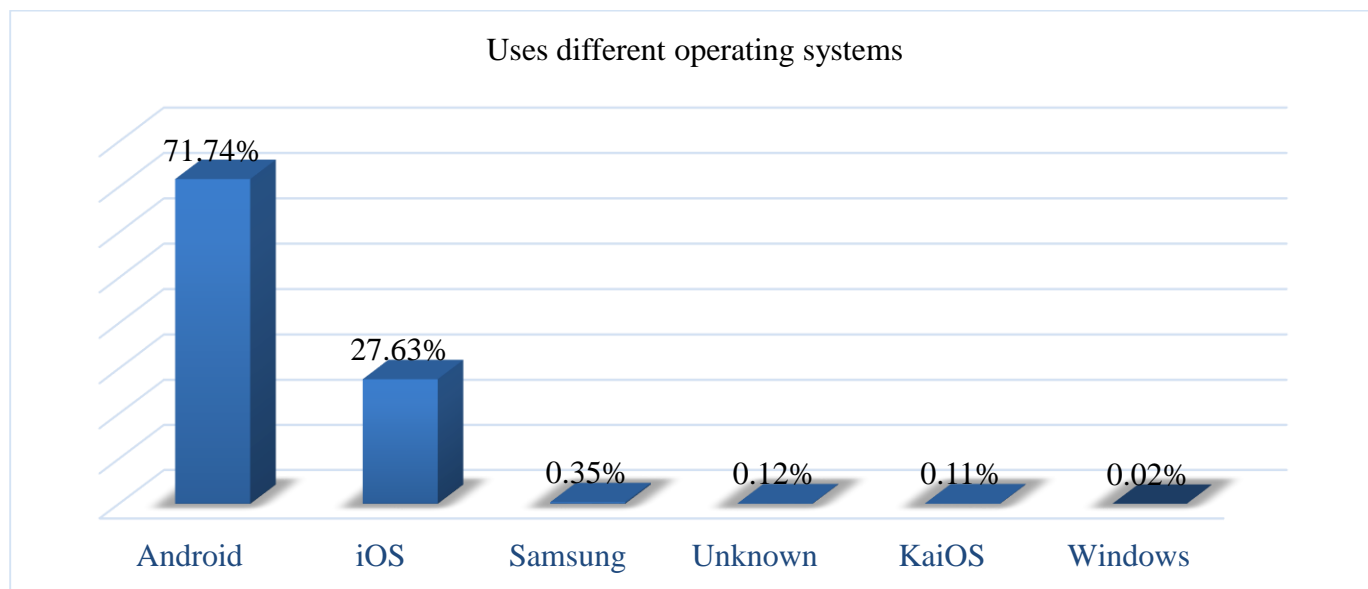


Fig .2 Displays the percentage of phones that uses different operating systems

Conclusion

In this paper, explains about the android versions and also shown architecture details and how to manage hardware in android operating system and also some details about previous android versions and mainly this research about the latest version of android that is android 7.0 Nougat and also about its features and details about its release. Android Nougat is that version of android developed by Google which recovers the all drawbacks of marshmallow and also it contains extended features. By doing so side by side with enhancing user experience android operating system would gain the trust of its users and would further strengthen its market share and will hold the users. Google has effectively presented android operating system as an open source and available for multiple devices by different manufacturers. Now the time has come for Google to lay quality bench marks on the device manufacturers who are using android operating system to ensure user experience and upheld the operating system standards that would also guarantee security protocols to be followed. By doing so, android operating system can overcome the loopholes and criticism faced by the competitors and would emerge as a user friendly platform that cares for its users. This paper covers some of the viewpoints of Android OS.

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