

## Smartphone OSs

# Android Evolution

## Android Evolution

### ❖ Android

- Android Beta
  - Released in November 2007
  - Beginning of the Android mobile OS (Operating System)
- Android 1.0
  - Released in September 2008
  - First commercial Android OS
- Android versions are linked with API Levels

## Android Evolution

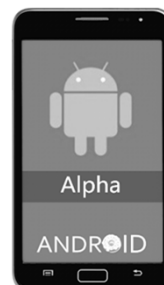
### ❖ API Level

- API (Application Programming Interface)
- API Level is a general indicator of how much the Programmer can communicate with built in functions of a device
- Higher API levels indicate increased functionality control

## Android Evolution

### ❖ Android 1.0 Alpha (API level 1)

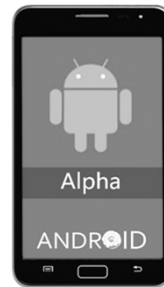
- Grouping of Folders  
    ➔ Single Folder Icon
- Access to web e-mail servers
- Wi-Fi and Bluetooth support
- Google Sync
- Wireless synchronization of Gmail, People, and Calendar



## Android Evolution

### ❖ Android 1.0 Alpha (API level 1)

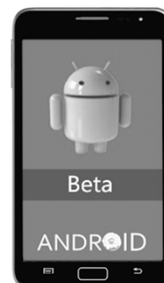
- Basic Applications
  - Calendar, Maps, Street View, Talk Voice Dialer, Wallpaper
- Additional Applications
  - (Phone) Dialer
  - (Launcher) Home Screen
  - (Gallery) Pictures
  - Alarm Clock
  - Calculator



## Android Evolution

### ❖ Android 1.1 Beta (API level 2)

- Released in February 2009
- Released on the HTC Dream smartphone
- Attachments in messages can be saved



## Android Evolution

### ❖ Android 1.5 Cupcake (API level 3)

- Released in April 2009
- Starting with Android 1.5 "Cupcake," Android versions were each given a confectionery code name in alphabetical order
- Web Browser Copy and Paste
- User pictures added for Favorites in Contacts
- Screen Transitions with Animation



## Android Evolution

### ❖ Android 1.5 Cupcake (API level 3)

- Auto-pairing and stereo support for Bluetooth A2DP and AVRCP profiles
- A2DP (Advanced Audio Distribution Profile)
  - Defines how multimedia audio can be streamed from one device (e.g., smartphone) to another device (e.g., wireless headset, hearing aid, car audio) over Bluetooth



## Android Evolution

### ❖ Android 1.5 Cupcake (API level 3)

- AVRCP (Audio/Video Remote Control Profile)
  - Enables a single remote controller to control all local A/V equipment (e.g., TVs, Hi-Fi equipment)
  - Can be used with A2DP
- Third-Party Virtual Keyboards
  - Text Prediction
  - Custom Words User Dictionary



## Android Evolution

### ❖ Android 1.5 Cupcake (API level 3)

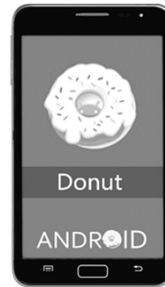
- Widget
  - Miniature application that can be inserted into another application
  - Receives periodic updates
  - Used in home screen customization
  - Touching leads to direct app access
  - Widget Examples
    - Weather widgets
    - Clock widgets
    - Sports score trackers



## Android Evolution

### ❖ Android 1.6 Donut (API level 4)

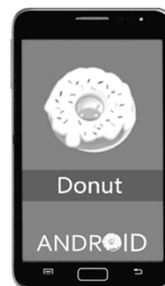
- Released in September 2009
- Text-to-Speech Engine
- Multi-Lingual Speech Synthesis Engine
  - Android applications can “Speak” a string of text
- Enhanced fully integrated Gallery, Camera, and Camcorder
  - Faster camera access



## Android Evolution

### ❖ Android 1.6 Donut (API level 4)

- Multiple photo selection for deletion
- CDMA/EVDO and 802.1x support
- VPN (Virtual Private Network) support
  - Virtual point-to-point private dedicated network connection setup in a public network
  - Virtual tunneling protocols and packet traffic encryption commonly used



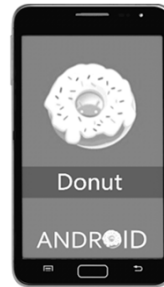
## Android Evolution

### ❖ Android 1.6 Donut (API level 4)

- WVGA (Wide Video Graphics Array)

Screen support

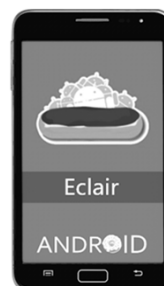
- Wider VGA screen with same 480 Pixel Height
- Aspect Ratio 3:2
  - 720x480
- Aspect Ratio 5:3
  - 800x480
- Approximate Aspect Ratio 16:9
  - 848x480, 852x480, 853x480, 854x480



## Android Evolution

### ❖ Android 2.0 Éclair (API level 5)

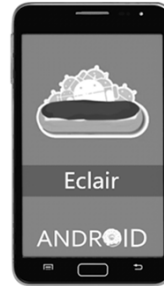
- Released in October 2009
- Account Sync
  - Multiple User Accounts on a single device
  - Synchronization of e-mail and contacts
- Bluetooth 2.1 support



## Android Evolution

### ❖ Android 2.0 Éclair (API level 5)

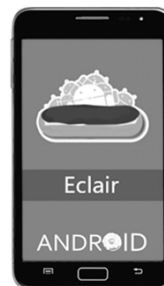
- Can search all saved SMS and MMS messages
- New Camera Features
  - Flash Support
  - Digital Zoom
  - Scene Mode
  - White Balance
  - Color Effect
  - Macro Focus



## Android Evolution

### ❖ Android 2.0 Éclair (API level 5)

- Enhanced Google Maps
- Enhanced Virtual Keyboard
  - Improved Typing Speed using dictionary suggestions
    - Includes words used by the user
    - Includes user contacts names





## Android Evolution

### ❖ Android 2.0 Éclair (API level 5)

- Motion Event class
  - Track multi-touch events
- Live Wallpapers
  - Home-Screen Background Animation
- Microsoft Exchange e-mail support



## Android Evolution

### ❖ Android 2.2~2.2.3 Froyo (API level 8)

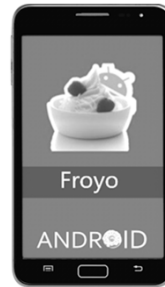
- Released in May 2010
- Android C2DM (Cloud to Device Messaging) support
  - Enables push notification for third-party developers
  - Used in E-mail, Contacts, and Calendar



## Android Evolution

### ❖ Android 2.2~2.2.3 Froyo (API level 8)

- Adobe Flash support
- USB Tethering
- Wi-Fi Hotspot
- Multiple Keyboard Languages and Dictionary Quick switching



## Android Evolution

### ❖ Android 2.3~2.3.2 Gingerbread (API level 9)

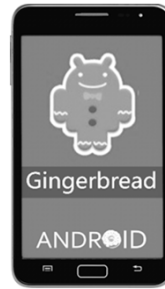
- Released in December 2010
- Front and Back Camera support
- Improved Virtual Keyboard
  - Intuitive text input
  - Improved accuracy
  - Improved suggested text and voice input mode



## Android Evolution

### ❖ Android 2.3~2.3.2 Gingerbread (API level 9)

- Easy-to-use Copy & Paste
  - Word selection by Press-Hold → Copy → Paste
- SIP based VoIP (Voice over IP) support
  - SIP (Session Initiation Protocol) supports signaling and controlling of IP multimedia communication sessions
  - VoIP, Video Call, Instant Messaging



## Android Evolution

### ❖ Android 2.3~2.3.2 Gingerbread (API level 9)

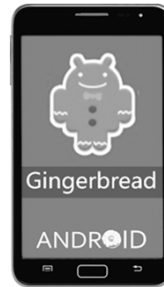
- More Sensor support
  - Gyroscope, Barometer, etc.
- NFC (Near Field Communication)
  - Used to exchange small information segments
  - Application examples
    - Payments, Posters, Stickers, Advertisement



## Android Evolution

### ❖ Android 2.3.4 Gingerbread (API level 10)

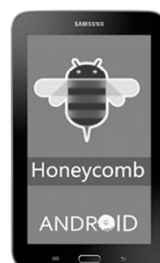
- Released in April 2011
- Support for Voice or Video Chat using Google Talk
  - Google Talk is an Instant Messaging service
  - Provides text and voice communication



## Android Evolution

### ❖ Android 3.0 Honeycomb (API level 11)

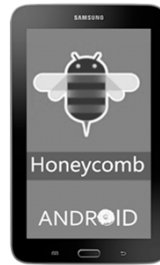
- Released in February 2011
- Simplified multitasking
- First Tablet only Android OS
  - Optimized for Smart Tablets



## Android Evolution

### ❖ Android 3.0 Honeycomb (API level 11)

- Action Bar
  - Top of the Screen Access
    - Contextual options, Navigation, Widgets, etc.
- System Bar
  - Bottom of the Screen Access
    - Notifications, Status, and Soft Navigation Buttons, etc.



## Android Evolution

### ❖ Android 3.0 Honeycomb (API level 11)

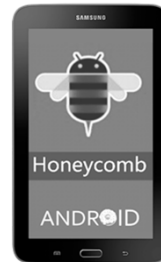
- Improved Tablet Keyboard
  - Improvements for faster, more efficient, and more accurate typing on larger Tablet screens
- Camera Features Quick Access
  - Camera exposure, focus, flash, zoom, front-facing camera, time-lapse, etc.



## Android Evolution

### ❖ Android 3.0 Honeycomb (API level 11)

- Multi-Core Processor support
- External I/O Device support
  - Android 3.1 Honeycomb
    - API level 12
  - Released on May 10, 2011
  - Keyboards, Pointing Devices, Joysticks, Gamepads, etc.



## Android Evolution

### ❖ Android 4.0~4.0.2 Ice Cream Sandwich (API level 14)

- Released in October 2011
- Easier-to-Create Folders
  - Drag-and-Drop creation
- Enhanced Visual Voicemail
  - Controllable Speed-Up or Slow-Down Voicemail messages



## Android Evolution

### ❖ Android 4.0~4.0.2 Ice Cream Sandwich (API level 14)

- Face Unlock
  - Facial recognition based smartphone unlocking
- Improved Camera functionality
  - Zero shutter lag, time lapse settings, panorama mode, zoom control during recording



## Android Evolution

### ❖ Android 4.0~4.0.2 Ice Cream Sandwich (API level 14)

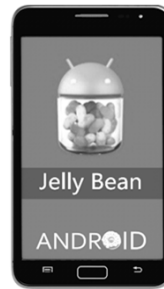
- Location and Person based gallery layout
- Built-in Photo Editor
- Wi-Fi Direct



## Android Evolution

### ❖ Android 4.1 Jelly Bean (API level 16)

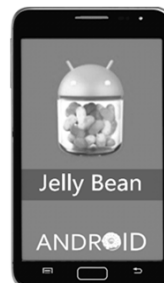
- Released in July 2012
- Bi-directional text and other language support
- Bluetooth data transfer



## Android Evolution

### ❖ Android 4.1 Jelly Bean (API level 16)

- Android Beam
  - Instant file sharing of two NFC enabled phones by touching each other
- Keymaps (Keyboard maps)
  - Additional international keymaps and special layout keyboard types can be installed

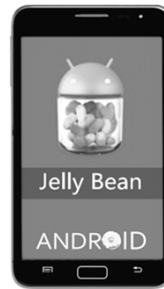




## Android Evolution

### ❖ Android 4.1 Jelly Bean (API level 16)

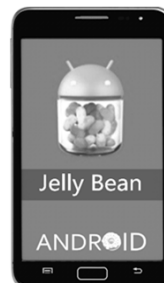
- Multi-Channel Audio
  - Supported on smartphones with Multi-Channel Audio output through HDMI
  - For non-equipped devices, Android automatically down-mixes the audio to fit the number of audio channels supported by the smartphone



## Android Evolution

### ❖ Android 4.3 Jelly Bean (API level 18)

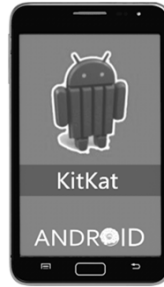
- BLE (Bluetooth Low Energy) support
- AVRCP 1.3 support
  - AVRCP (Bluetooth Audio/Video Remote Control Profile)



## Android Evolution

### ❖ Android 4.4 KitKat (API level 19)

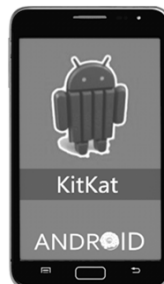
- Released in October 2013
- Wireless Printing
- Step detector and counter
- NFC Host Card emulation
  - Smartphones are capable of replacing smart cards
- Sensor batching
  - Collects and delivers sensor events efficiently in batches



## Android Evolution

### ❖ Android 4.4 KitKat (API level 19)

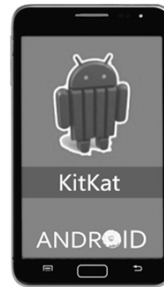
- Loudness Enhancer
  - Increase the loudness of speech in media playback apps
- Built-in Screen Recording
  - Primarily for developers
    - Use of ADB (Android Debug Bridge) is required
- Bluetooth MAP (Message Access Profile)
  - Apps can exchange messages with a nearby device



## Android Evolution

### ❖ Android 4.4 KitKat (API level 20)

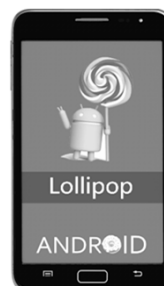
- Released in June 2014
- Wearable Extensions
  - Android Wear platform for smartwatches



## Android Evolution

### ❖ Android 5.0~5.0.2 Lollipop (API level 21)

- Released in November 2014
- 64 bit CPU support
- Audio Input and Output through USB devices



## Android Evolution

### ❖ Android 5.0~5.0.2 Lollipop (API level 21)

- 3rd-party applications can read and modify data on external storages (e.g., SD cards)
- Memory of recently used applications
  - Even after restarting the device the memory of recently used apps is maintained



## Android Evolution

### ❖ Android 5.0~5.0.2 Lollipop (API level 21)

- Addition of 15 new languages
  - Basque, Bengali, Burmese, Chinese (Hong Kong), Galician, Icelandic, Kannada, Kyrgyz, Macedonian, Malayalam, Marathi, Nepali, Sinhala, Tamil, and Telugu



## Android Evolution

### ❖ Android 5.1 Lollipop (API level 22)

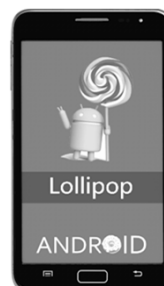
- Released in March 2015
- Official support for multiple SIM cards
- Device protection
  - If a device is lost or stolen, the device will remain locked until the owner signs into their Google account



## Android Evolution

### ❖ Android 5.1 Lollipop (API level 22)

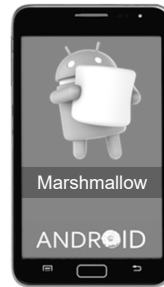
- High-definition voice call support
  - Only between 4G LTE devices



## Android Evolution

### ❖ Android 6.0 Marshmallow (API level 23)

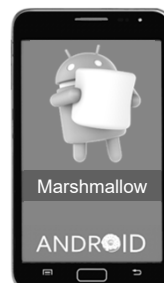
- Released in October 2015
- Google "Now on Tap" feature
  - By holding down the home button, Google automatically searches inside apps for similar things that are displayed on the screen
- Doze mode
  - In order to save battery power, Doze mode reduces the CPU speed when the screen is off



## Android Evolution

### ❖ Android 6.0 Marshmallow (API level 23)

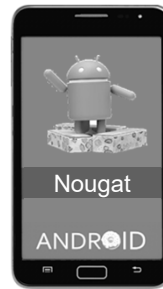
- Native fingerprint reader support
- USB Type-C support
- 4K display mode for apps
- Adoptable External storage to behave like Internal Storage



## Android Evolution

### ❖ Android 7.0~7.1 Nougat (API level 24 / 25)

- Released in August 2016
- Native Multi-window
  - Displays multiple apps on-screen simultaneously in a split-screen view
- Daydream
  - VR (Virtual Reality) platform developed by Google
  - Works on phones and headsets with wireless controllers



## Android Evolution

### ❖ Android 8.0 Oreo (API level 26)

- Released in August 2017
- 2 times faster boot time (Measured on Google Pixel Phone)
- Picture-In-Picture (PIP) mode
- Multi-display support
- Notification improvements
  - Notification channels
  - Notification dots (badges)
  - Notification snoozing



## Android Evolution

### ❖ Android 8.0 Oreo (API level 26)

- Google Play Protect
  - Security system for Android devices
- Android Instant Apps
  - Use new apps from web browser without installation



## Android Evolution

### ❖ Android 8.0 Oreo (API level 26)

- Project Treble
  - New modular architecture for easy and fast Android updates
  - Separation of Android OS framework (by Google) and vendor implementation (by Hardware makers)





## Smartphone OSs

# References

### References

- Android Developers, <http://developer.android.com>
- Android, <https://www.android.com>
- V3, Top 10 reasons to be excited by Android Ice Cream Sandwich, <http://www.v3.co.uk/v3-uk/news/2119111/reasons-excited-android-ice-cream-sandwich20150513> [Accessed June 1, 2015]
- Wikipedia, <http://www.wikipedia.org>