# Android Architecture & Fundamentals

#### Overview

- Android OS Background
- Android Architecture
- Core Fundamentals
- Kotlin Introduction



## What is Android?

- Open source mobile OS based on Linux kernel
- UI for touch screens
- Used on ~88% of smartphones
- Runs on Phones, TVs, Wearables, and Cars
- ~ 3 Million Android apps in Google Play store

## Mobile App Development

- Native
- Cross Platform (Hybrid)
- Web (PWA)







#### Android Android Studio Kotlin/Java & XML

**iOS** Xcode Swift/Objective-C





## **Cross Platform Apps**

**Flutter** Dart By Google



**React Native** JavaScript By Facebook



Xamarin Forms C# & XAML By Microsoft



## Progressive Web Apps (PWA)

Any application that can works in a web browser for desktop & mobile devices

- Client-side JavaScript Frameworks
  - Javascript, HTML, CSS
  - Web Frameworks
    - React, Angular, Vue



## Mobile Dev Apps Comparison

	Native	Cross-platform	PWA
Shared Code Base	0%	About 80%-95%	100%
Access to OS API	Full	Most of them	Limited
Performance	Best	In-between (depending on the framework used)	Worst

# Why Android?

### Android Development

• Development Supported on many Operating Systems





## Google Play

- The App Store for Android Apps
- Hosts large variety of Apps
- Google Play Console
  - Develop and Publish App
  - Access to Billions of Users
  - Adjust and Iterate App Showcasing
  - Maintain App after Deployment
  - View User Reviews

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## Android Software Developer Kit (SDK)

- Development tools (debugger, monitors, editors, Android Studio)
- Libraries (maps, wearables)
- Virtual devices (emulators)
- Documentation (developers.android.com)
- Sample code





## Android is like an Onion, it has a lot of layers



Android Platform Architecture



## Android Architecture

- Hardware Abstraction Layer (HAL) -Standard interfaces that expose hardware capabilities as libraries
- Linux Kernel Android relies on this for drivers, threading, security, and memory management



## Android Platform Architecture

- System Apps Android comes with these default core applications
- Java API Framework you have access to the same APIs used by the core applications
- Native C/C++ Libraries Underneath API Framework
- Android Runtime Each app runs in its own process with its own instance of the Android Runtime

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		Java API	Framew	ork						
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### Android Architecture Summary

- System Apps
- Java API Framework
- Native C/C++ Libraries
- Android Runtime
- Hardware Abstraction Layer (HAL)
- Linux Kernel



## Core Fundamentals

## Android Versions

- Each version adds new features and changes
- Depending on the manufacturer, the Android OS used can be modified



Name	Version	Released	Supported	API level
Jelly Bean	4.1 – 4.3.1	July 2012	No	16 – 18
KitKat	4.4 - 4.4.4	Oct 2013	No	19 – 20
Lollipop	5.0 – 5.1.1	Nov 2014	No	21 – 22
Marshmallow	6.0 - 6.0.1	Oct 2015	No	23
Nougat	7.0 – 7.1.2	Aug 2016	No	24 – 25
Oreo	8.0 – 8.1	Aug 2017	Yes	26 – 27
Pie	9	Aug 2018	Yes	28
Android 10	10	Sept 2019	Yes	29
Android 11	11	Sept 2020	Yes	30

## **API levels**

- Target API level
  - Version that the developer wants to design the application for
- Minimum API level
  - Oldest version the application will be backwards compatible with

ŀ	NDROID PLATFORM VERSION	<b>API LEVEL</b>	CUMULATIVE DISTRIBUTION
4.0		15	
4.1	Jelly Bean	16	99.8%
4.2	Jelly Bean	17	<mark>99.2%</mark>
4.3	Jelly Bean	18	98.4%
4.4	KitKat	19	98.1%
5.0	Lollipop	21	94.1%
5.1	Lollipop	22	92.3%
6.0	Marshmallow	23	84.9%
7.0	Nougat	24	73.7%
7.1		25	66.2%
8.0	Oreo	26	<mark>60.8%</mark>
8.1	Oreo	27	53.5%
9.0	Pie	28	39.5%
10.	Android 10	29	8.2%

## Android App Fundamental Background

- Single or Multiple interactive screens
- Written with:
  - Kotlin/Java and XML
- Uses:
  - Android Software Development Kit (SDK)
  - Android libraries and Android Application Framework
- Executes:
  - Android Runtime Virtual machine (ART)

## Some Core Challenges

- UI/UX:
  - Multiple screen sizes and resolutions
  - Accessibility
- Performance:
  - make your apps responsive and smooth
- Security:
  - keep source code and user data safe
- Compatibility:
  - run well on older platform versions
- Marketing:
  - understand the market and your users
  - (Hint: It doesn't have to be expensive, but it can be.)

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# Exploring Android File Structure

#### Android View



#### **Project Files View**



#### View Modes



Manifest: declares essential information about app for the runtime

- Every app must include it
- Declared Information about the application
  - App name
  - Components
  - Permissions
  - Required libraries

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# Manifest: declares essential information about app for the runtime

- Every app must include it
- Declared Information about the application
  - App name
  - Components
  - $\circ$  Permissions
  - Required libraries

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#### Source Code (JVM): activities,

services, and helper classes

- Kotlin source code under "Java" folder
- Contains MainActivity

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#### Source Code (JVM): activities,

services, and helper classes

- Kotlin source code under "Java" folder
- Contains MainActivity

🚱 MainActivity.kt package com.android.example.filestructure import androidx.appcompat.app.AppCompatActivity import android.os.Bundle 4 override fun onCreate(savedInstanceState: Bundle?) { }

**Resources:** Layouts, images, strings, colors as XML and media files in key value pairs

- Contains app resources
  - Layouts
  - Values
  - Strings
  - Images
  - Audio
  - Color
  - & More!



**Resources:** Layouts, images, strings, colors as XML and media files in key value pairs

- Contains app resources
  - Layouts
  - Values
  - Strings
  - Images
  - Audio
  - Color
  - & More!

#### ᡖ colors.xml

<?xml version="1.0" encoding="utf-8"?>

#### <presources>

## **Gradle:** Determines the proper order of tasks to run

- Manages the build cycle via a series of tasks
  - Compiles Kotlin sources, runs tests, installs app to device
- Builds automation system
- Manages dependencies between projects and third-party libraries
- Common tasks include:
  - Clean
  - Tasks
  - InstallDebug



## Gradle Scripts (top-level)

- build.gradle (Project: apptitle)
- top-level build file for the entire project
- defines build configurations that apply to all modules in your project

b@ldscript { ext.kotlin version = "1.3.72" repositories { google() dependencies { 8 classpath "org.jetbrains.kotlin:kotlin-gradle-plugin:\$kotlin version" allprojects { repositories { google() task clean(type: Delete) { delete rootProject.buildDir

## Gradle Scripts (module-level)

- build.gradle (Module: app)
- separate build files for each module
- edit the build settings to provide custom packaging options for each module
- Build types, product flavors, ...
- Overrides top-level build.gradle

```
apply plugin: 'com.android.application'
agly plugin: 'kotlin-android'
apply plugin: 'kotlin-android-extensions'
android {
    compileSdkVersion 29
    buildToolsVersion "30.0.1"
    defaultConfig {
        applicationId "com.example.myapplication"
        minSdkVersion 24
        targetSdkVersion 29
        versionCode 1
        versionName "1.0"
        testInstrumentationRunner "androidx.test.runner.AndroidJUnitRunner"
    buildTypes {
        release {
            minifyEnabled false
            proguardFiles getDefaultProguardFile('proguard-android-optimize.txt'), 'proguard-rules.pro'
dependencies {
    implementation "org.jetbrains.kotlin:kotlin-stdlib:$kotlin version"
    implementation 'androidx.appcompat:appcompat:1.2.0'
    implementation 'androidx.constraintlayout:constraintlayout:2.0.1'
    testImplementation 'junit: junit: 4.12'
    androidTestImplementation 'androidx.test.ext:junit:1.1.2'
    androidTestImplementation 'androidx.test.espresso:espresso-core:3.3.0'
```



# Android Development Basics

## Create a Project



## Android Studio

- 1. Toolbar
- 2. Navigation bar
- 3. Editor window
- 4. Tool window bar
- 5. Tool windows
- 6. Status bar



## Android Studio - Layouts

- 1. Project Window
- 2. Palette
- 3. Components Tree
- 4. Design Editor
- 5. Attributes

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## **Activities - Introduction**

- An Activity tells Android how the app should interact with the user
- Every Android app contains at least one activity
- Activities range from showing displays of:
  - Lists from a feed (ie: Reddit)
  - Details about individual items (ie: Amazon Shopping)
  - Using other apps to achieve functionality (ie: Snapchat Filters)

#### MainActivity.kt

- Where core app behavior gets defined
- Can change views dynamically
- Work with functions like onCreate() to create views and bind data



## Activities - MainActivity.kt

#### • MainActivity.kt

- Where core app behavior gets defined
- Can change views dynamically
- $\circ$  Work with functions like onCreate() to create views

and bind data



## Activities - A Closer Look



## Android Studio - Emulator

- Android Virtual Device (AVD) manager
  - Creates virtual device/emulator simulating an Android-powered device
- Use AVD Manager to
  - Define hardware characteristics of a device and its API level, and to save it as a virtual device configuration.
  - Upon starting, the emulator reads a specified configuration and emulates a device that behaves like a physical phone/device



## Create and Run a Virtual Device

#### Tools > Android > AVD Manager, or click the AVD Manager icon

			A	ndroid Vir	tual Device Manager			
×	Your Virtual [ Android Studio	Devices	5					
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ablet	Nexus One		3.7"	480x800	hdpi	
	Nexus 6P		5.7"	1440x2	560dpi	5.2* 1920px
	Nexus 6		5.96*	1440x2	560dpi	
	Nexus 5X	⊳	5.2"	1080x1	420dpi	
	Nexus 5	⊳	4.95*	1080x1	xxhdpi	
	Nexus 4		4.7"	768x12	xhdpi	
lew Hardwar	e Profile Import Ha	rdware Profiles		700-40	Ø	5 Clone Devic

Run > Run app OR Click the Android Studio Run icon Run

## Debugging

- The log is a debugging tool to look at values, execution paths, and exceptions
- To see the Logcat pane, click the Logcat tab at the bottom of the Android Studio window
- Set to default Verbose (shows all Log messages.) Other settings include Debug, Error, Info, and Warn.

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## Logging Example

- Log tags are defined as constants for the Activity:
  - private static final String LOG\_TAG = MainActivity.class.getSimpleName();
- Types of logs
  - d: Debug, e: Error, w: Warn, i: Info
- Sample log statement
  - Log.d(LOG\_TAG, "Hello World");
- Expected Output:
  - o 11-24 14:06:59.001 4696-4696/? D/MainActivity: Hello World