PS03CMCA52 MOBILE APPLICATION DEVELOPMENT

Dr. J. V. Smart

Table of Contents

Syllabus

Syllabus with effect from the Academic Year 2021-2022

Course Code	PS03CMCA52	Title of the Course	MOBILE APPLICATION DEVELOPMENT

Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. Understanding of Components and Working of Mobile Applications. 2. Gain Knowledge of Designing, Coding and Deployment of Mobile Applications using Android Studio IDE.

Course Content

Unit	Description	Weightage* (%)
1.	**Introduction** - Introduction to Prominent Mobile Application Development Platforms: Android, iOS, Windows - Overview and Evolution of Android, Features of Android - Android System Architecture - Key Android concepts — SDK, API, AVD, DVM - Types of Android Applications - Android Application Components: Intent, Activity, Service, Broadcast Receiver, Content Provider, Sync Adapters - The Android Activity Life Cycle - Introduction to Android Application Development Environment: Android Studio - Anatomy of the Android Project	25
2.	**Android User Interface Design** - Views: Basic, Picker, Lists - Toast, Alert Dialog - Layouts - Handling Events of UI Components - Units of Measurement: dp, sp, px, pt - Intents: Explicit and Implicit - Adapters: Array and Cursor - Menu: Options and Context - Notifications	25
3.	**Data Persistence** - Understanding of Data Persistence in Android	25

Unit	Description	Weightage* (%)
	- Shared Preferences - File System Access - Introduction to the SQLite Database and DB Browser - Creating and Managing the SQLite Database - Using Different Types of Content Providers	
4.	**Advanced Android Programming** - Multimedia: Images, Audio, Video - Accessing the Camera Using Intent - Broadcast Receivers - Services - Text Messages(SMS) - Accessing Files and Data From a Remote Server, Web Services - Location Based Services	25

Teaching-Learning Methodology	Blended learning approach incorporating traditional classroom teaching as well as online / ICT-based teaching practices

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	To develop Mobile Applications for Android Platform.
2.	To understand Components and Working of Mobile Applications.

Suggested References:

Sr. No.	References
1.	Lee Wei-Meng : Beginning Android Appilcation Development, Wiley Publishing, Inc., 2011.
2.	Meier Reto : Professional Android Application Development, Wiley Publishing, Inc., 2010
3.	Darwin I. A. : Android Cookbook, O'Reiley Media, Inc., 2012

On-line resources to be used if available as reference material	
1.	https://developer.android.com

Introduction

Android is an operating system originally designed for touchscreen-based smartphones, but has since been extended for tablets, televisions, smartwatches, automobiles and other devices as well. Android was originally developed by Android, Inc. Google purchased the company in 2005. The Open Handset Alliance (OHA), consisting of Google, device manufacturers like HTC, Sony and Samsung and various wireless carriers and chipset makers, was formed in 2007 for developing and promoting open standards for mobile computing, including Android. Android is an open source operating system. HTC Dream, launched in October 2008, was the first commercially available Android phone. Since then Android, alongside Apple's iOS, has become one of two operating systems that run most of the smartphones and tablets. Android also runs on television sets, smart watches, automobile docks, etc.

A new version of Android is first developed internally by Google and a Google Pixel series device is launched with the new version. The Pixel series devices provide the "pure" Android experience. After that, the source code is released under the Android Open Source Project (AOSP). Manufactures take this source code, add device drivers to it, customize it, put their own user interface elements ("skins") on top of it and compile it for their devices. In this way, most Android devices run a slightly or heavily modified version of Android.

Structure

Android is based on Linux and uses a modified Linux kernel. Android is a multitasking, multiprocessor, multithreading operating system. Applications for Android are called Apps. Apps are developed using the Java programming language and the Android SDK (Software Development Kit). Android uses the Dalvik virtual machine or ART (Android Run Time) for executing the Java code. Android devices can have a wide variety of input / output components, communication mechanisms as well as sensors and actuators and the Android SDK lets the apps access these. Apps are typically downloaded from an app store, Google Play being the most common of them. Apps have various revenue models including completely free apps, ad-supported apps, in-app purchases, trial versions, and paid apps. Availability of a large number of apps in the app store is a major strength of the Android platform. The apps run in their own sandboxes; each app that is installed gets its own Linux user and runs under that user's privileges. Access to hardware and sharing of data between different applications are restricted and require explicit permissions.

Key Characteristics

- Android is a complete platform for smartphones; it provides the operating system, the development platform, the SDK, the execution platform and a range of standard services
- It is free and open source
- Supported by the Open Handset Alliance, including Google, device manufacturers like HTC, Sony and Samsung and various wireless carriers and chipset makers
- Based on Linux
- Supports a range of hardware devices, small and large
- Applications are developed on a modified Java platform
- Applications can access a wide variety of hardware and system elements, including telephony, Wi-Fi, text messaging, PIM (Personal Information Management) information like contacts, address book, SMS inbox, etc., camera, Bluetooth, motion sensors, GPS, streaming media, file system, database management system and so on
- The SQLite lightweight relational database management system is used for database management
- OpenGL graphics library is used for 2D and 3D graphics
- Custom applications have almost the same powers as built-in ones
- Custom applications may replace the built-in applications without having to

modify the operating system
- Security is enforced. All applications run in sandboxes. Explicit permission from the user is needed to access anything outside the sandbox
- Multitasking and multithreading are supported
- The system manages an application's lifecycle, enabling more efficient battery and memory usage
- Applications (Apps) are typically installed from the App Store (standard Android supports Google Play, formerly known as Google App Store, but customized versions may restrict access only to specific app stores)
- There is support for free, paid, trial version and ad-supported apps as well as in-app purchases
- Android is designed from the beginning to support internationalization

The Development Platform

- The Java programming language is used for Android development. Google has added support for the Kotlin programming language as well and since May 2019, Kotlin is the preferred programming language for Android development
- A class library (the Android SDK) that includes some classes from the Java class libraries, but not all. In particular, user interface is reworked and there are no AWT or Swing classes. It also has a large number of classes of its own. It provides the programmer almost complete access to the platform and the hardware
- Earlier, Android used the Dalvik Virtual Machine (DVM) instead of the JVM. Dalvik VM has JIT (just-in-time compiler) and is said to be optimized for performance on mobile devices. It now users ART
- Java .class files can be compiled into Dalvik .dex executables using the dx tool, one dex file may contain multiple classes
- Starting with Android 4.4 (KitKat), A new experimental AOT (Ahead-of-Time) compiler and runtime known as ART (Android Runtime) was provided as a developer option on an experimental basis. ART Compiles the Dalvik byte code to native code for the specific device at the time of installation, providing a boost in performance. The installer can also preselect and optimize resources like images for the particular device screen
- ART is the default runtime starting with Android 5.0 Lollipop
- Applications are packaged into APK (Android Package) format. An APK file usually contains everything needed to install and run the app, including the

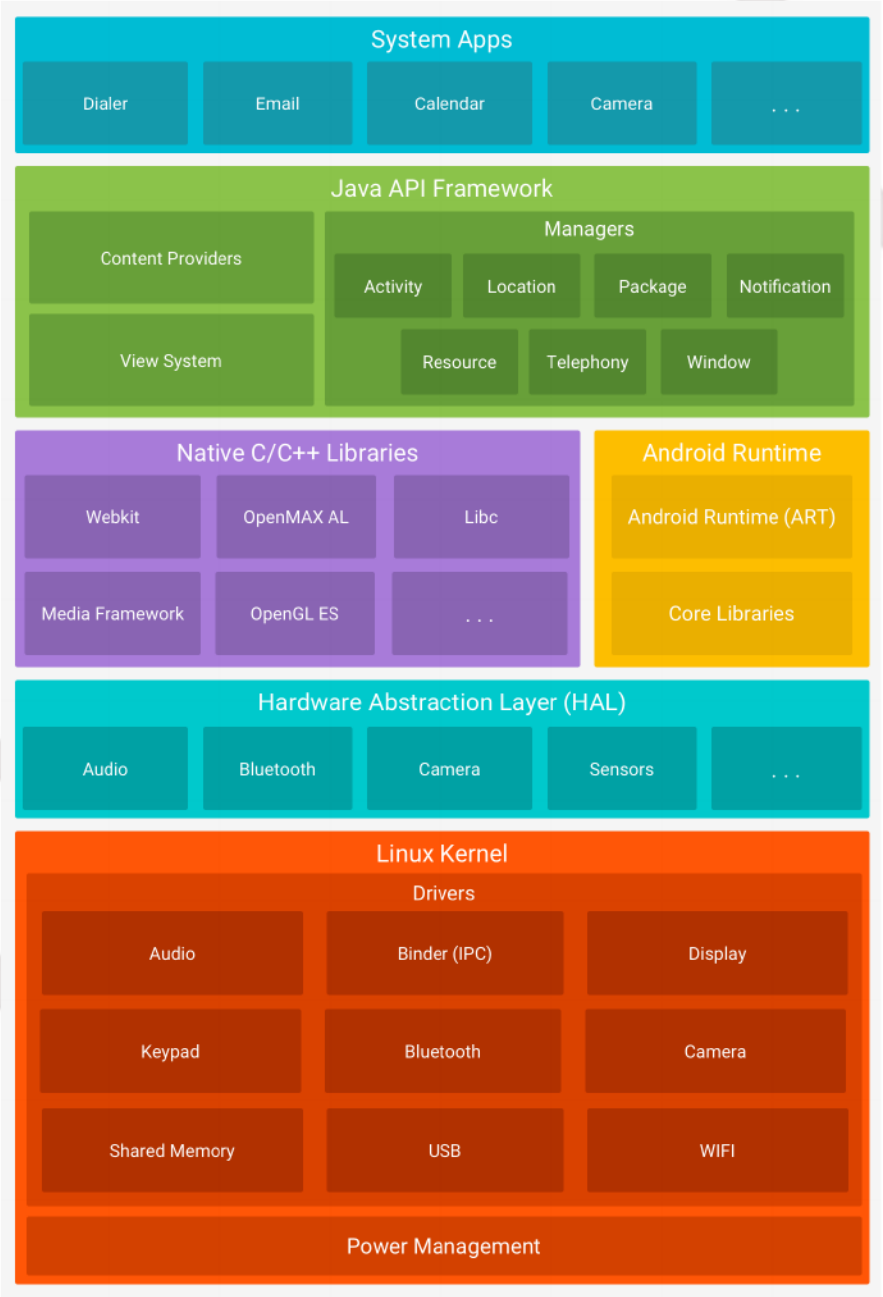
byte code for the various classes in the program, meta data, configuration files, resources (like strings, images, dimensions, styles), etc.

- Applications can access a wide variety of hardware and system elements
- The SQLite lightweight relational database management system is used for database management
- Event-driven programming environment
- Separation between user interface and application logic
- Applications have little control over their life cycle; it is managed by the system for optimal use in a resource-constrained environment. An application that is not interacting with the user at the moment may be terminated anytime without notification. When the user brings the application back to the foreground, it must provide an illusion that it was always running and was never terminated. This requires storing and restoring the state of the application on appropriate events

The Android Logo

The New Android Logo

Android System Architecture



Android System Architecture

Android Versions

Android Versions

Version	Codename	API
4.0.3-4.0.4	Ice Cream Sandwich	15
4.1.x	Jelly Bean	16
4.2.x	Jelly Bean	17

Version	Codename	API
4.3	Jelly Bean	18
4.4	KitKat	19
4.4w	KitKat with wearable extensions	20
5.0	**Lollipop**	**21**
5.1	**Lollipop**	**22**
6.0	**Marshmallow**	**23**
7.0	**Nougat**	**24**
7.1	**Nougat**	**25**
8.0	**Oreo**	**26**
8.1	**Oreo**	**27**
9.0	**Pie**	**28**
10.0	**Q**	**29**
11.0	**R**	**30**
12.0	**S**	**31**

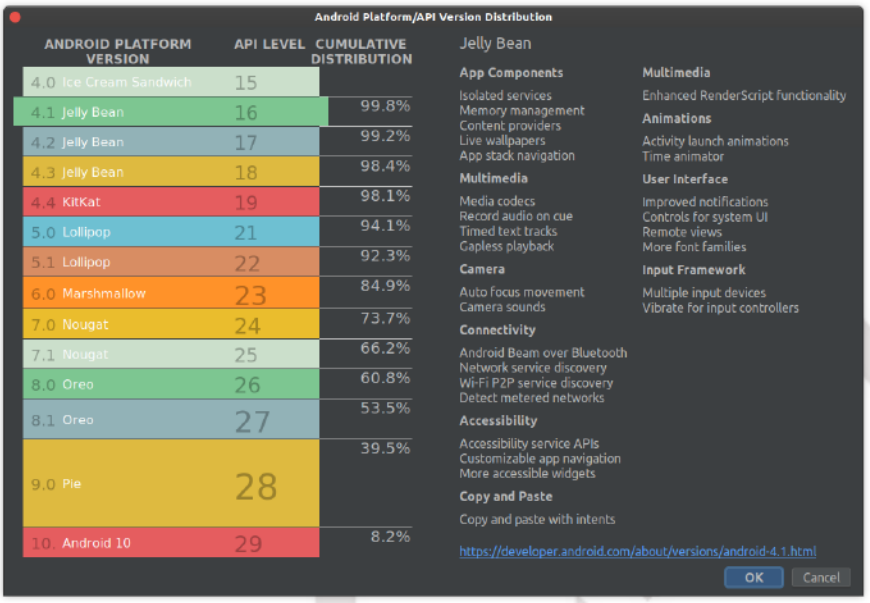
Android Version Distribution (as on July 2021)

(Can be seen when creating a new project in Android Studio using the *Help Me Choose* link when selecting the minimum SDK level)

Android version Distribution

Version	Codename	API	Distribution
4.1.x	Jelly Bean	16	0.6%
4.2.x	Jelly Bean	17	0.8%
4.3	Jelly Bean	18	0.3%
4.4	KitKat	19	4.0%
5.0	Lollipop	21	1.8%
5.1	Lollipop	22	7.4%

Version	Codename	API	Distribution
6.0	Marshmallow	23	11.6%
7.0	Nougat	24	7.1%
7.1	Nougat	25	5.4%
8.0	Oreo	26	7.3%
8.1	Oreo	27	14.0%
9.0	Pie	28	31.3%
10.0	Q	29	8.2%
11.0	R	30	?
12.0	S(Beta)	31	N/A



Android Version Distribution

Developing for Android

Android Studio

- Google has developed the Android Studio IDE specifically designed for Android development
- It is based on the IntelliJ IDEA platform (an IDE for Java)
- It is now the default application development tool for Android

The Gradle Build Tool

Dependency

When a software component X uses another software component Y, X is said to depend on Y and Y is said to be a dependency of X. X and Y may be projects, modules, libraries or programs

Build

The process of building software involves compiling source programs, collecting the dependencies, dependencies of dependencies, and so on recursively and then creating a software package that can be deployed (installed) to a target device. When software is rebuilt after a change, the build process only recompiles those parts that have been changed or are dependent on parts that have been changed. Similarly, only newly added dependencies are downloaded and the dependencies of those dependencies are downloded and so on, recursively

Build Tool

A build tool is used to build software. It may maintain a dependency tree and build only those parts of the software project that have changed or need to be built again because a dependency has changed

Packaging

The process of converting a software project into a form (the software package) that can be deployed (installed) to a target device is called packaging. Typically, packaging removes the source code and other components needed for development and keeps only the components needed for executing the project

Deployment

The process of *installing* a software package to a target device is called deployment

- Android uses the Gradle build tool. Gradle is an enterprise grade build tool designed for managing the build process of large software applications. By default, it assumes Internet connectivity. But Android Studio provides a *work offline* mode

Key Concepts in Android Development

Android Virtual Device (AVD)

An AVD is an emulator used to emulate specific hardware and software configuration. To test our application against different hardware/software platforms, we may create multiple AVDs.

Activities

Activities represent the application's presentation tier. Each activity represents a screen that displays some information and may let the user interact with it.

An Android application may consists of a number of activities. Each activity is a single user interface screen. One activity may invoke another activity. Android maintains an Activity Stack. The activity that the user is currently interacting with is always at the top of the Activity Stack. When that activity starts another activity, the newly started activity is pushed on the top of the stack. When the newly started activity finishes, it is popped from the Activity Stack, bringing the previous activity to the top of the stack again. The lifecycle of activities is managed by the Android system itself. To conserve scarce resources, especially battery power and memory, Android may terminate a running activity at any time. The activity is supposed to save its state when an event signaling the possibility of such termination occurs. When the activity is restarted, it is passed the previously saved state as a Bundle. The activity should use it to restore itself such that the user has a seamless experience and does not realize that the activity was terminated and restarted in-between. An activity may also be terminated and restarted when a configuration change, especially a change in the screen orientation or the locale, occurs. See Android Activity Lifecycle

Views

Views are the basic building blocks of the user interface. They represent (visible or invisible) items that are part of the configuration of the display. Views are the equivalent of GUI components (Java) and controls (.NET). Examples of views are TextView, EditText, Button, ListView, etc. that display information in different forms and may let the user interact with it. Views can be nested (one view inside another).

A ViewGroup is a special type of view used to group several (sub)views together. Layouts are (invisible) ViewGroups.

Fragments

A Fragment represents a reusable part of the app's user interface. A fragment defines and manages its own layout, has its own lifecycle, and can handle its own input events. Fragments cannot live on their own - they must be hosted by an activity or another fragment. The fragment's view hierarchy becomes part of, or attaches to, the host's view hierarchy. At runtime, one may programmatically add a fragment to an activity, remove a fragment from an activity or replace an existing fragment in an activity with another. Fragments are managed using FragmentManager and FragmentTransaction classes. One or more fragments can also be included in an activity's layout XML file.

Resources

Android follows the philosophy of keeping the presentation separate from the application logic. Hence everything except the code is defined as resources separate from the code.

Different Types of Resources

- **Drawables** Drawables are graphics resources that can be painted on the screen. They include icons and images. To cater to different screen sizes, we may have folders like res/drawable-ldpi, res/drawable-mdpi, res/drawable-hdpi, res/drawable-xhdpi, res/drawable-xxhdpi, etc. corresponding to screens with low, medium, high, extra-high and extra-extra-high DPI (Dots Per Inch) screens respectively. Examples of these types of screens would be a small-screen mobile phone, a large-screen mobile phone, a phablet or a 7" tablet, a large tablet and a TV screen respectively. The Android baseline is mdpi. If resources for some screen size are not provided, the nearest-sized resources are automatically scaled to the required sizes by Android. However, this may affect performance and leave visible artefacts on the screen. Having different sized icons and images for different sized screens ensures that the application has nice looks on all types of devices. In certain optimizations of the build process, only the version of the drawable suitable for a given display is kept in the final APK file and other versions are removed. However, such optimizations are used only by few apps
- **Mipmaps** Mipmaps are application icon drawables. The reason for keeping them in separate folders called mipmap-* is that some launchers display application icons from a different (usually higher) density setting compared

to the actual device density to make them look larger and / or crisper. Putting the different versions of the application icon in the mipmap folders ensures that all the versions of the icon will be retained in the final APK file and none will be removed due to build optimization

- **Layouts** Layouts are ViewGroups that are not rendered (displayed) themselves, but are used to hold and organize other views geometrically on the screen. layouts decide the sizes and arrangements of the views on screen at runtime. Because there may be a wide variation in screen sizes between different devices, it is not recommended to use fixed sizes and positioning. The typical way of constructing user interface screens is to define the layout in a layout file in XML format and then generate the necessary views at runtime from the XML definition. this process is called layout inflation. Like drawables, we may define diferent layouts for different screen sizes and Android will pick the most suitable one based on the actual screen size at runtime. We may also create views programmatically at runtime without defining them in an XML file. Layouts can be nested one inside another to create a complex layout
- **Menus** The menus to be used with an activity are defined separately from the code in XML files. The reasons for doing this are two-fold - to keep language specific menu titles (or images) separate for easy changeability and to design separate menus to go with separate screen layouts
- **Values** There are different types of values that are stored in XML files separately from the code for easy changeability. They are:
    - **Dimensions** sizes of various items. We may have different values for different screen sizes
    - **Strings** No string should be hard-coded anywhere in the application code or other resource files (e.g. layouts). All such strings, including labels for view on the screen, titles, menu item titles, etc. should be defined in the strings XML file. This enables internationalization, where the strings may be translated into different languages by non-developers or third parties without going through or having access to the source code. The systems picks the correct strings XML file at runtime based on the locale (language) settings in effect on the user's device
    - **Styles** Styles are used to define visual appearance of view. They work very similarly to CSS (Cascading Stylesheets). To ensure maximum portability across different devices, one should never define any visual characteristics anywhere other than in styles. One style may inherit from another style. There are several built-in styles and a programmer

may define one's own style as well. A style applied at the entire application level is called a theme. Themes are used to ensure consistent look and feel throughout the application. They also provide a central place for the styles for easy changeability and for avoiding duplication

- **Advantages of using Resources**
  - Separating the presentation from the logic
  - Ability to change the visual design of the app without affecting the code
  - Providing different screen layouts, menus and graphic resources (e.g. images/icons) for different screen sizes
  - Supporting internationalization (multiple languages, different date formats, different number formats, etc.)

Resource IDs and the R class

Android Project Structure

Support Libraries

AndroidX

Units of dimensions

Android supports a variety of units for specifying the dimensions of various elements. Some of them are:

- **px** pixels
- **pt** points (1 point = 1/72 of an inch)
- **mm** millimeters
- **in** inches
- **dp** dp (density-independent pixels) is the recommended unit for specifying dimensions because it considers the screen density (dots per inch) and scales the dimensions accordingly. On different Android devices with very different screen densities, this unit preserves the overall appearance and proportions
- **sp** sp (scaled pixel) is a unit designed for use with text (e.g. font size). Some Android devices let the user choose the font size (small / medium / large). All apps are expected to respect this choice. The unit sp scales

according to the user's choice of font size

- **em** em stands for the height / width of the letter `M`. In modern usage, em is usually equal to the font size (in points)

Configuration qualifiers for different pixel densities

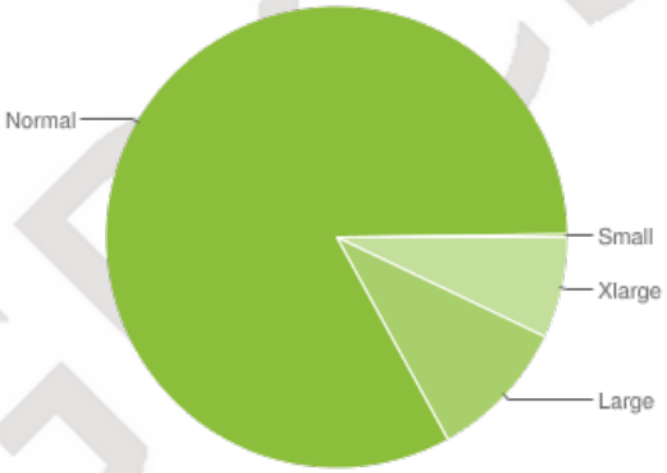
Pixel density is measured in *dpi* (dots per inch). Higher dpi values result is crisper display.

Density qualifier	Description
`ldpi`	Resources for low-density (*ldpi*) screens (~120dpi)
`mdpi`	Resources for medium-density (*mdpi*) screens (~160dpi) (This is the baseline density)
`hdpi`	Resources for high-density (*hdpi*) screens (~240dpi)
`xhdpi`	Resources for extra-high-density (*xhdpi*) screens (~320dpi)
`xxhdpi`	Resources for extra-extra-high-density (*xxhdpi*) screens (~480dpi)
`xxxhdpi`	Resources for extra-extra-extra-high-density (*xxxhdpi*) uses (~640dpi)
`nodpi`	Resources for all densities. These are density-independent resources. The system does not scale resources tagged with this qualifier, regardless of the current screen's density
`tvdpi`	Resources for screens somewhere between mdpi and hdpi; approximately 213dpi. This is not considered a "primary" density group. It is mostly intended for televisions and most apps shouldn't need it---providing mdpi and hdpi resources is sufficient for most apps and the system will scale them as appropriate. If you find it necessary to provide tvdpi resources, you should size them at a factor of 1.33*mdpi. For example, a 100px x 100px image for mdpi screens should be 133px x 133px for tvdpi

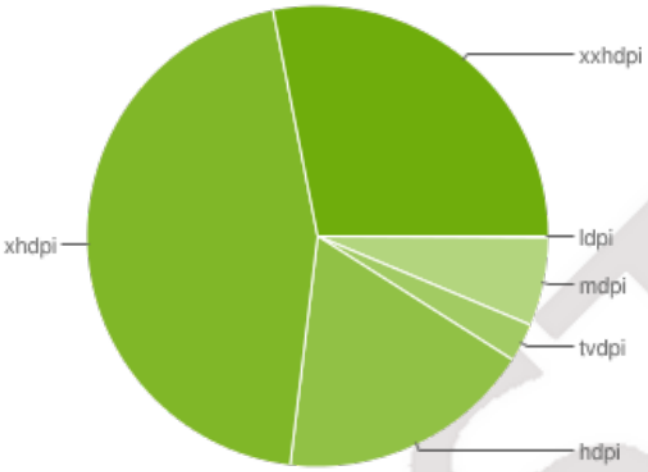
Screen Sizes and Densities

Distribution of Screen Sizes and Densities as on 08-01-2021

	ldpi	mdpi	tvdpi	hdpi	xhdpi	xxhdpi	Total
Small	0.1%				0.1%		0.2%
Normal		0.3%	0.3%	14.8%	41.3%	26.1%	82.8%
Large		1.7%	2.2%	0.8%	3.2%	2.0%	9.9%
Xlarge		4.2%	0.2%	2.3%	0.4%		7.1%
Total	0.1%	6.2%	2.7%	17.9%	45.0%	28.1%	



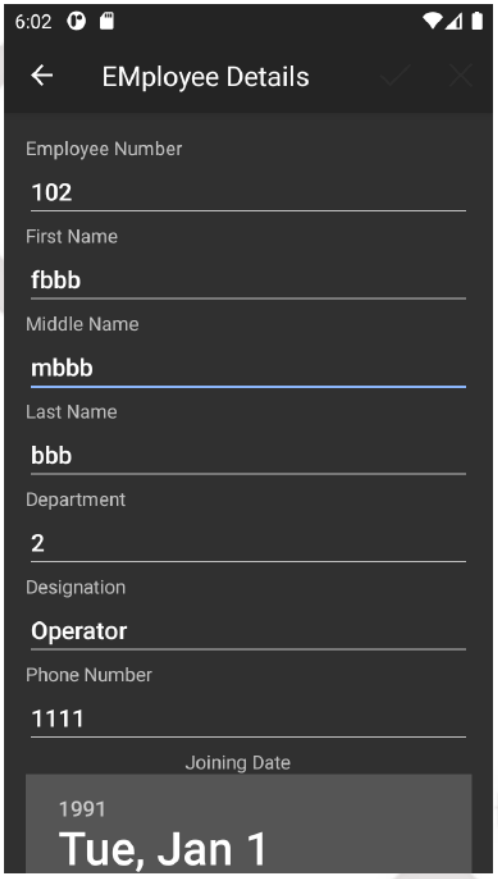
Distribution of Screen Sizes



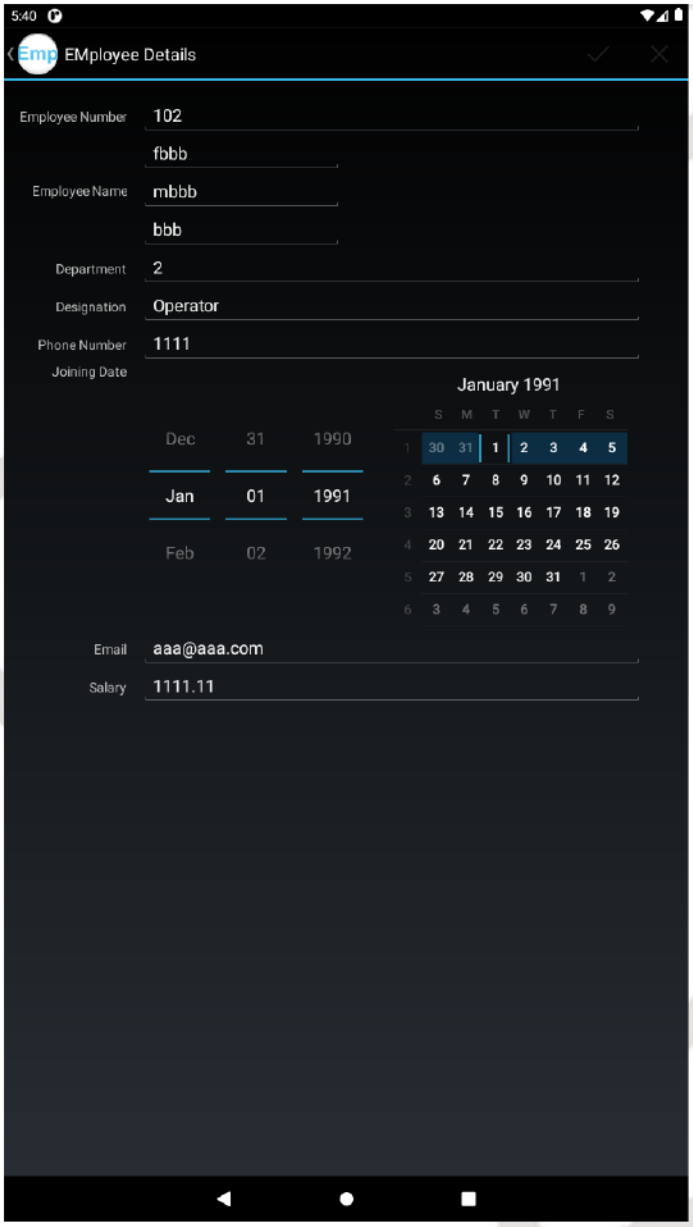
Distribution of Screen Densities

Different layouts for different screens

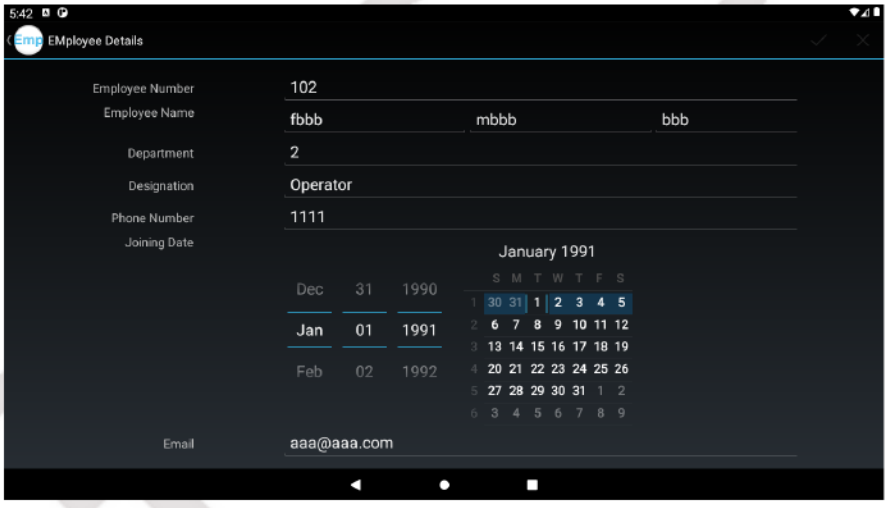
(App: EmployeeManagement6)



Default Layout



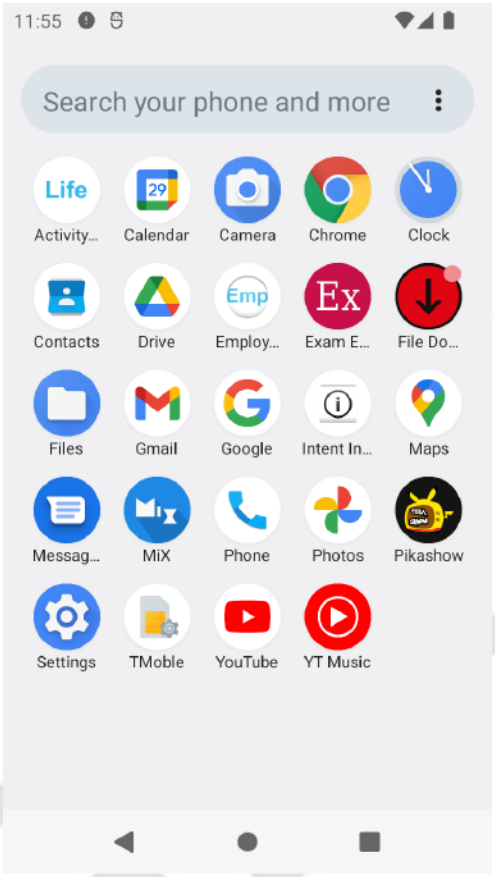
Large Portrait Layout



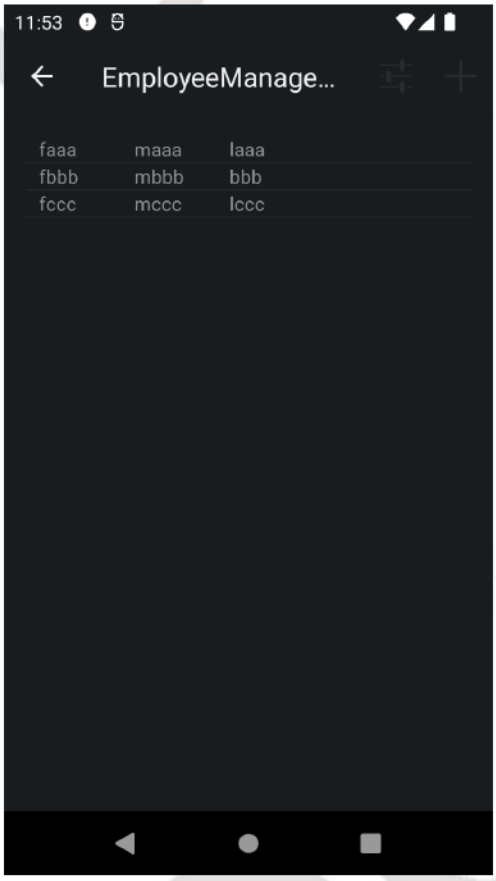
Large Landscape Layout

Different layouts for different languages

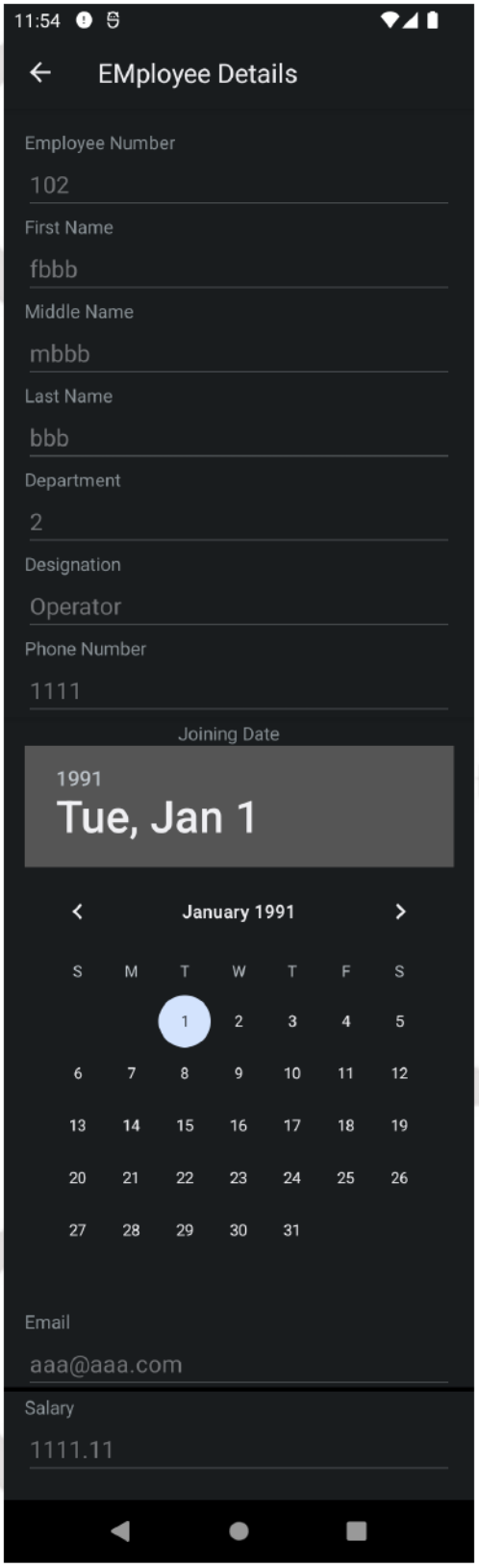
(App: EmployeeManagement6)



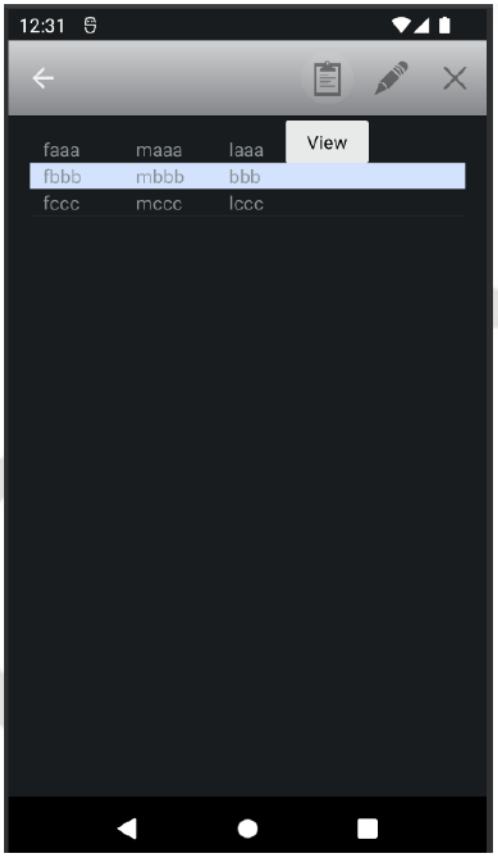
App Drawer English



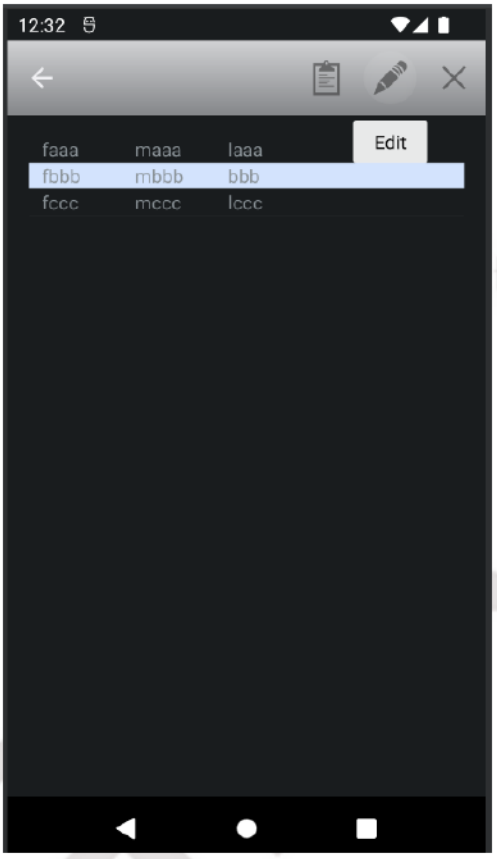
Employee List English



Employee Details English

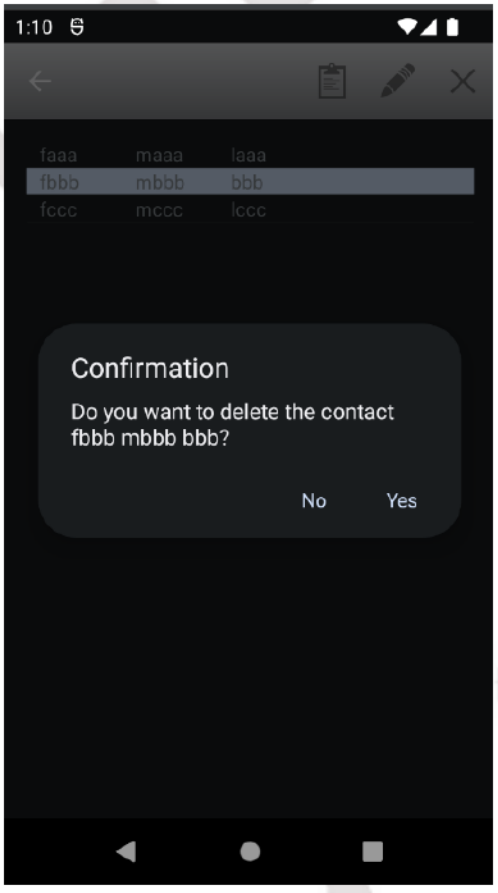


Employee Details View Menu English

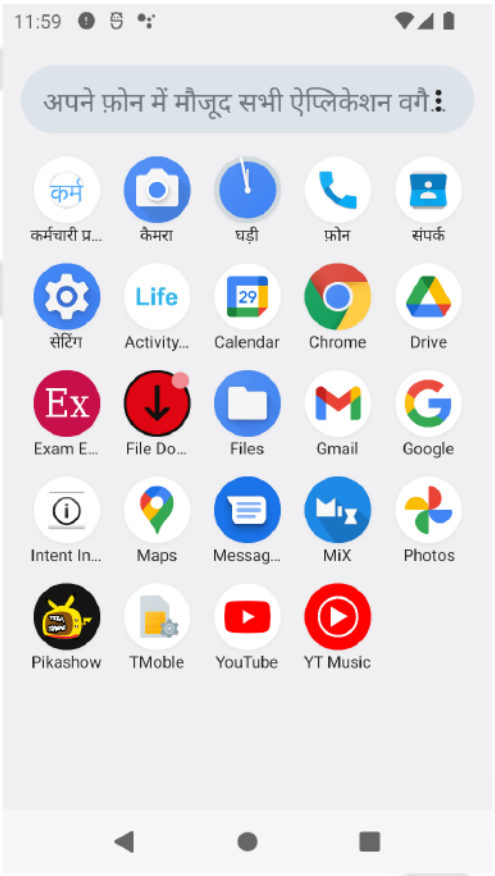


Employee Details Edit Menu English

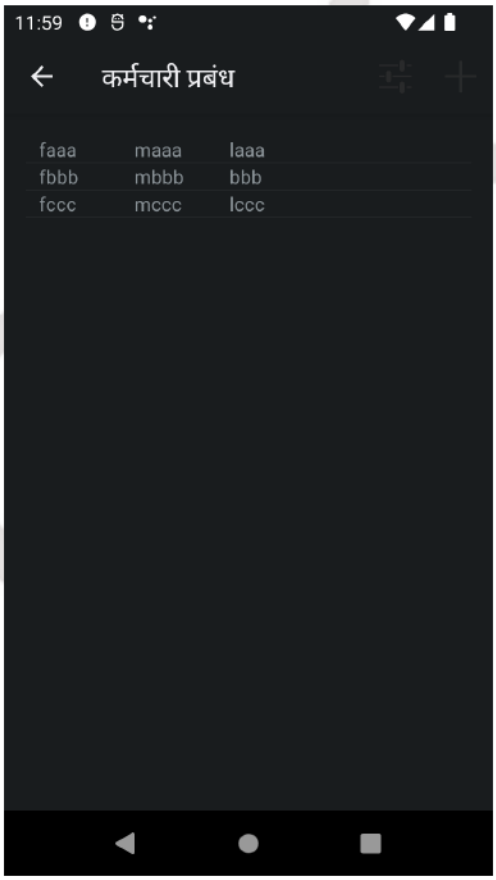
Employee Details Delete Menu English



Employee Details Delete Confirmation Dialog English



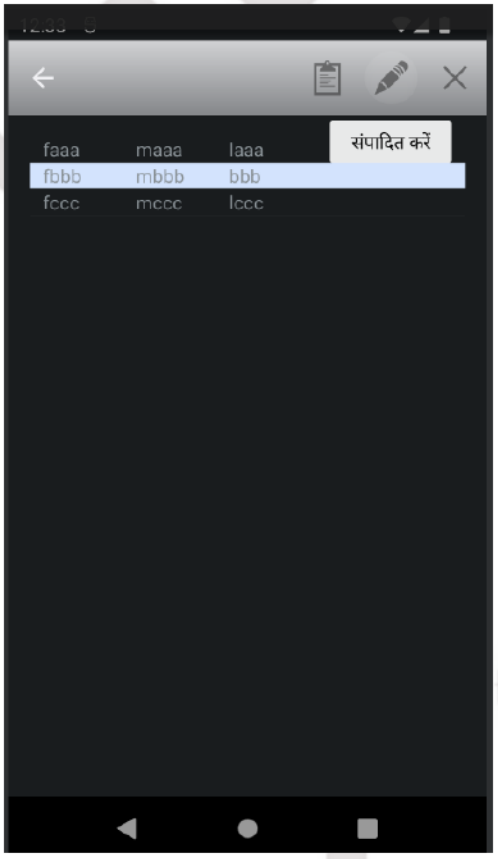
App Drawer Hindi



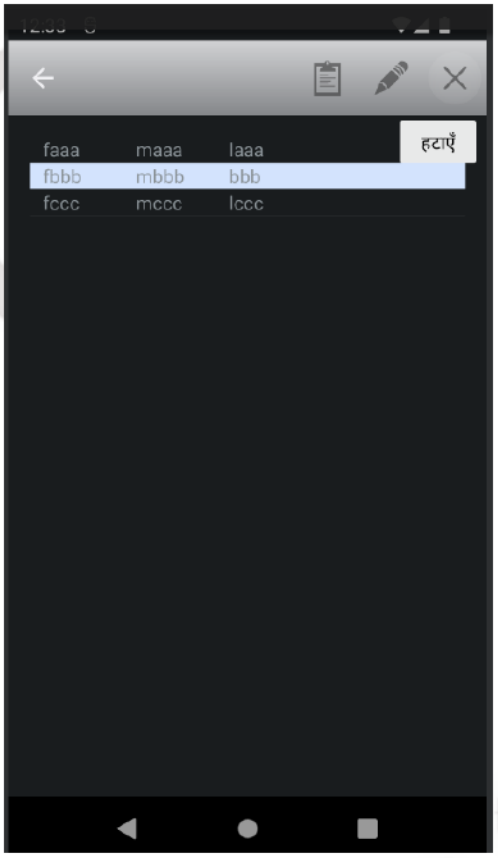
Employee List Hindi

Employee Details Hindi

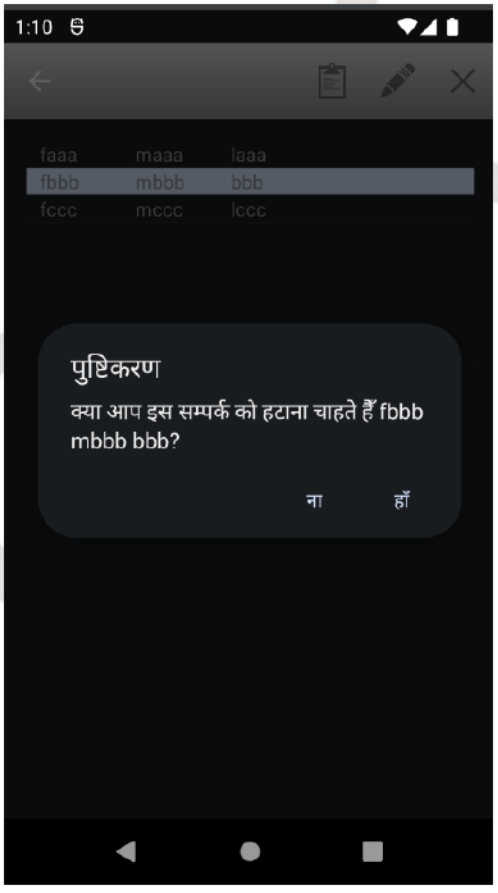
Employee Details View Menu Hindi



Employee Details Edit Menu Hindi



Employee Details Delete Menu Hindi



Employee Details Delete Confirmation Dialog Hindi

Services

A Service is a task (process) that runs in the background i.e. without any kind of user interaction. They are used for performing functions that are to be performed periodically without the user invoking the application or for taking some action when particular event occurs.

Notifications

Notifications are messages created by apps to draw the attention of the user or to inform the user about some event or ongoing activity. Notifications let you signal users without stealing focus or interrupting their current Activities. They're the preferred technique for getting a user's attention when your activity does not have the focus, say, from within a service or broadcast Receiver. For example, when a device receives a text message or misses an incoming call, it alerts you using a notification. There is a notification pull-down / notification shade where these notifications are stored until the user acts on them or dismisses them. On newer versions, the notifications in the notification pull-down may also include images, icons, formatted content or actionable elements, like buttons.

Home Screens

These are user-customizable screens. They are the Android equivalent of desktops or workspaces on the personal computers. When no activity is visible on the screen, one of the home screens is on display. The number of available home screens may be different on different devices. Users may decide the appearance of the home screen(s) and place application shortcuts and widgets on them for quick access and prominent display.

Application Widgets

Application Widgets are small visual application components that can be added to the home screen. Application Widgets can be used to create small dynamic, interactive application components for embedding on the home screen.

Note The term widget is used to mean user interaction elements (views) in the API reference, while the application widgets are called *AppWidgets*.

Uses of AppWidgets AppWidgets are used for different purposes:

- To display information that is automatically updated from a background service (e.g. clock, whether report, etc.)
- To provide controls for the phone (e.g. to mute/unmute phone, to

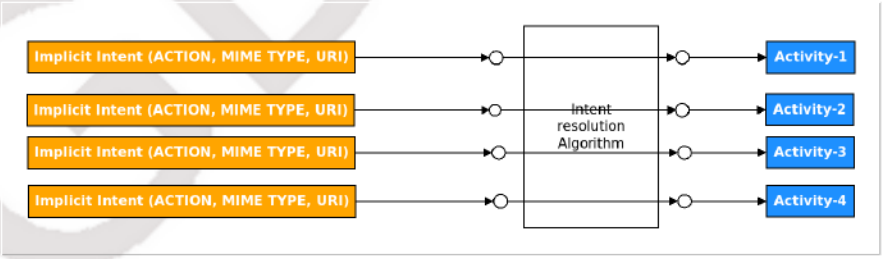
enable/disable Wi-Fi/Bluetooth, etc.)

- To invoke an activity when tapped

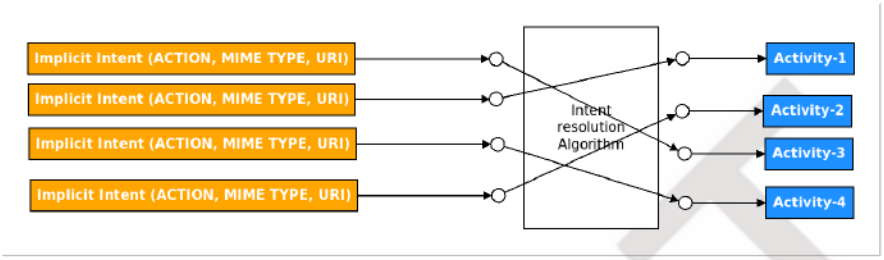
Intents

An intent is an abstract description of an operation to be performed. Intents are messages used for communication between components (like activities, services, broadcast receivers, etc) of the same app or different apps. Typically, an intent is created when some event occurs and it requires some action to be performed. There may be one or more components that may be capable of performing that action.

Android has an open architecture where the links between events and actions are dynamic and not hard-wired. Events and actions are connected via a kind of "switch board" such that the linkages between them can be easily changed just by changing the "internal wiring of the switchboard". It would not require any change in the code of the event producers, the actions or the operating system.



Intents-1



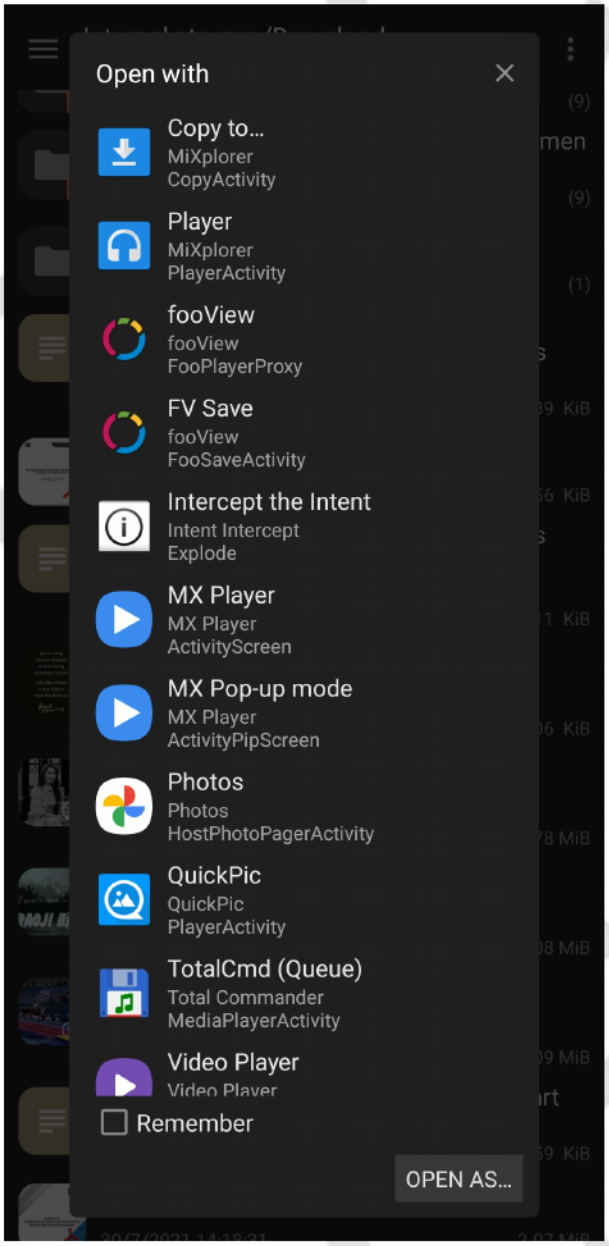
Intents-2

- **Explicit Intents** One may use an explicit intent to send the message to a specific target activity or service. This type of intent specifies the class of the component (activity / service) to be used for performing the operation. The system will hand over the intent to the specified activity or service for taking appropriate action
- **Implicit Intents** An implicit intent only specifies the operation to be performed. It dos not specify the component that may perform the operation. The Android operating system uses its own internal algorithm to

decide which component will handle the intent. Usually, if a default activity has been specified for the operation, it will be invoked directly. If there is exactly one component that can perform that operation, then also it will be invoked directly. Otherwise, the user will be presented with a *chooser* dialog having a list of suitable activities and the activity selected by the user will be launched to perform the operation

- **Intent Filters** An activity, service or broadcast receiver may define one or more intent filters in its respective entry in the Android manifest file. If one of these components has intent filters declared, it makes that component potentially eligible for receiving implicit intents and broadcast messages that match the criteria in the intent filter (appropriate permission may be required). No intent filters are required for receiving an explicit intent. One may use intent filters to declare interest in receiving messages of a particular type from components of the same app or other apps. One may also use them to substitute one's own application in place of the system's default application for handling certain types of events (like, for handling incoming text message or email)
- **Intent filter criteria** Intents are filtered based on several criteria. Some key criteria are as follows:
    - **Category** The category `CATEGORY_LAUNCHER` indicates that the activity is the main (home/first level) activity in the application. The activity appears in the list of apps and its shortcut may be placed on the home screen
    - **Action** An action indicates the action desired to be performed. There are several built-in actions that are extensively used by the system as well as apps. For example, `ACTION_VIEW` is used to display some content, `ACTION_EDIT` is used to initiate editing of some content, `ACTION_DIAL` is used to dial (call) a number, etc. App developers can also define their own actions
    - **Data** Contains additional data about the action to be performed. Data has two parts:
        • **URI** A URI that points to the data item to be manipulated
        • **MIME** type A MIME (Multimedia Internet Mail Extensions) type that indicated the type of the data item to be manipulated; e.g. text/plain (plain text), text/html (HTML), image/jpeg (JPEG image), image/png (PNG image), etc. There are standard and de-facto standard MIME types for a wide variety of content types
- **Default Activities** A user may define certain app / activity as the default for a particular type of intent. When an implicit intent of that type is executed,

Android will directly launch the default activity defined by the user for that type of intent. The user may change or remove the app (activity) defaults from *Settings*



The Chooser Dialog

Brodcast Messages

Usually a message is passed on to any one target activity or service. In the case of an explicit intent, the intent itself specifies the class of the target. In case of an implicit intent, the Android system determines one target for delivering the message using an algorithm. But in case of a broadcast message, the message is delivered to all recipients that have registered for receiving that type of messages one after another. Typically, the Android system generates broadcast messages for hardware and software events in which multiple apps may e interested, for example, a change in network state, a change in location, an

incoming text message, etc. User apps can also generate broadcast messages. Broadcast messages also use intents as the vehicle for carrying the message.

Broadcast Receivers

Broadcast Receivers are consumers of broadcast messages. If one creates a broadcast receiver in an application and registers it with the system, it will listen for system-wide broadcast Intents that match specified filter criteria. If a matching intent is fired and the broadcast receiver is selected by the Android algorithm for receiving it, the application will be invoked to respond to the Intent. (See code snippet at "Sending and Receiving Text Messages SMS")

Content Providers

Content Providers are potentially shareable data stores. Content Providers are used to manage and share application databases. They expose content through `content://` URIs. They are the preferred means of sharing data across application boundaries. One can configure one's own content providers to access data in a structured way or to give other applications access to one's data. One can also use the content providers exposed by other applications to access their data. Android devices include several native content providers that expose useful data like the media store (for accessing the media on the device like images, videos, music, etc.) and the contacts content provider that provides access to the device user's contacts.

Cursors

Cursors are scrollable result sets typically generated as a result of executing a SELECT query.

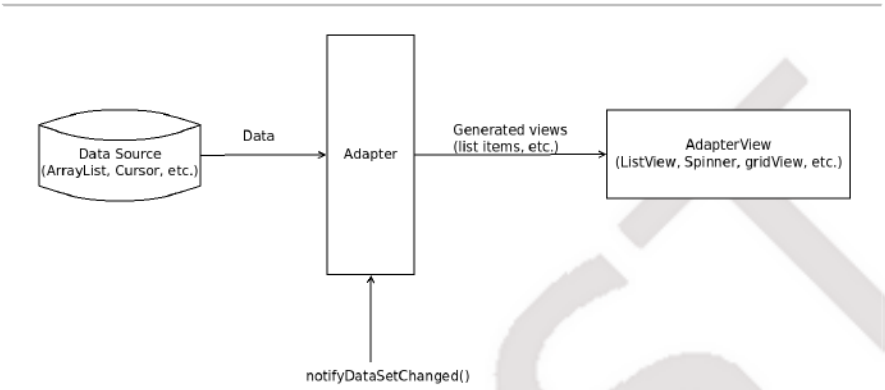
ListView

A ListView is a scrollable list consisting of 0 or more list items. Each list item may have one or more views (like TextView, ImageButton, CheckBox, etc.) in it as per its layout. Typically, a ListView is populated with list items dynamically using an adapter.

Adapters

An adapter takes data in a model or data source (an ArrayList, a cursor, etc.),

generates list items consisting of views (as per a list item layout), sets the data from the model in those views and populates an AdapterView (a ListView, a Spinner, a GridView, etc.) with those list items. Later, when the data in the data model change, the programmer should notify the adapter of the change and the adapter will automatically update the AdapterView in sync with the modified data. The generation of views can be customized. This pattern has been optimized for performance. For example, when a user scrolls a list, the views that go out of the display window are often reused.



Adapter

Logging

Android applications as well as the operating system itself post an extensive log of events that happen during their execution to a log database. The log is available in the Android Studio IDE in the *LogCat* window. We can put our own messages to the log using methods like `Log.i(TAG, message)`. These logs messages are a very important mechanism for debugging an app.

Toast/SnackBar

When an activity, typically running in the foreground, needs to display a short transient message to the device user, it uses *Toast*. The message is displayed as floating text for some duration and then disappears. Newer versions of Android also provide an enhanced version of Toast called *SnackBar*. The snackbar can also have actions in it.

Context

Context provides global information about an application environment and access to application-specific resources and classes, as well as application-level operations such as launching activities, broadcasting and receiving intents, etc.

A context object is needed whenever the code needs to access some system service or the user interface.

There are contexts at different levels - there is an activity-level context as well as a global application-level context.

`Context` is an abstract class. `Activity` class indirectly inherits from the `Context` class. Hence, every activity is an activity-level context. We can access the application-level context using the `getApplicationContext()` method of the `Activity` class.

Android Manifest File

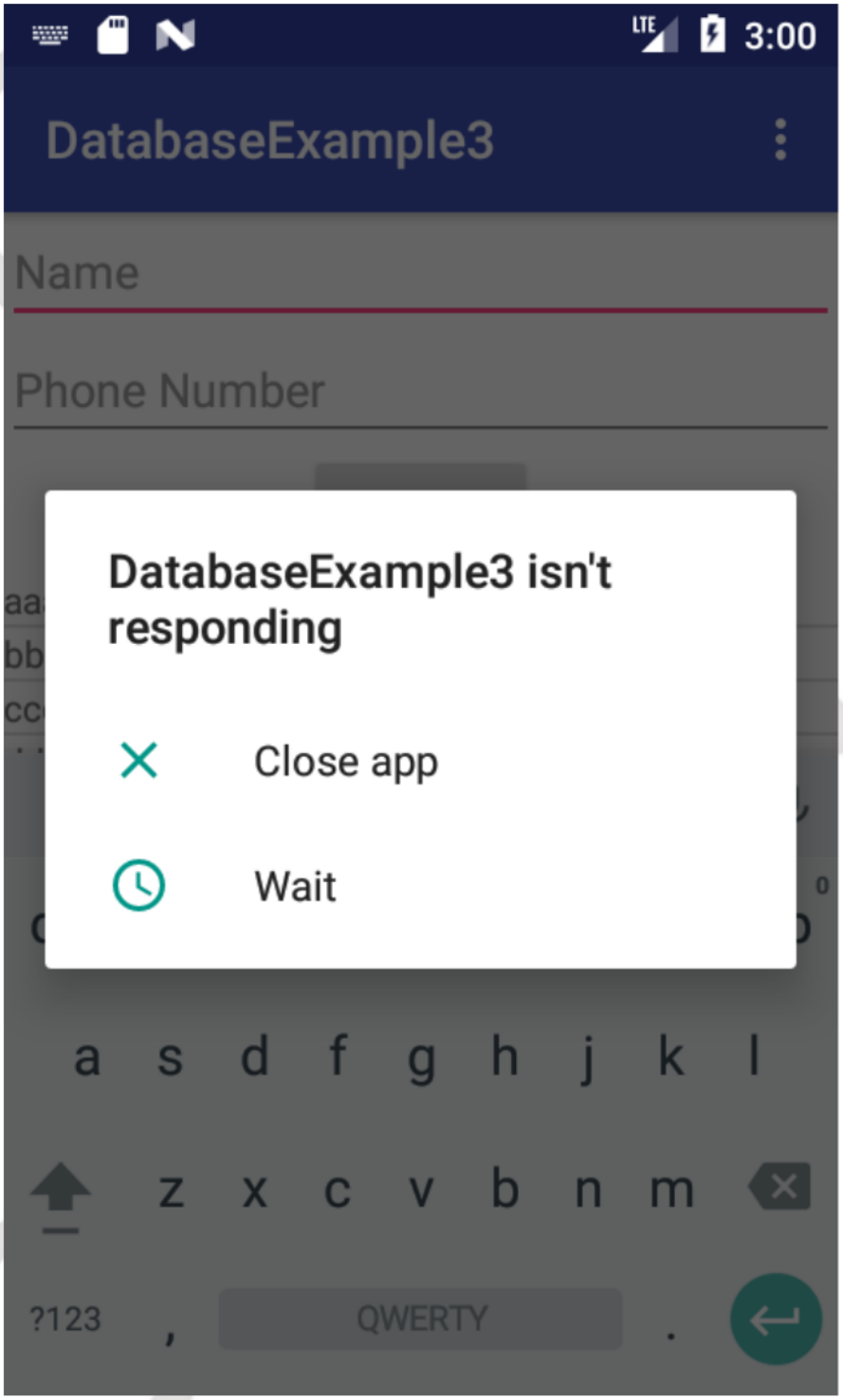
This is an XML file associated with the application. It specifies several key pieces of information about the application like:

- Package name
- Application version number (This has now been moved to the Gradle build file)
- The id of the application icon
- Information about which activity is the main activity in the application
- The minimum SDK version required to run the application (This has now been moved to the Gradle build file)
- The SDK version for which the application has been compiled (This has now been moved to the Gradle build file)
- The application name
- The theme used by the application
- The activities in the application and the intent filters for the intents they would like to receive
- The content providers in the application
- The services in the application
- The broadcast receivers in the application and the intent filters for the messages they would like to receive
- The permissions required by the application

The UI Thread

In Android, the User Interface (UI) thread, also known as the Event Dispatch Thread (EDT), handles all the user interface events. UI events, as they occur, are added to the event queue. The UI threads retrieves the events from the

event queue one by one and invokes the corresponding event handler on the same (UI) threads. Hence, the event handlers must return very quickly, else the UI thread will block waiting for the event handler to return. No UI event in the application can be processed while the event thread is blocked, causing the application to become unresponsive. Android has time limits in which an event handler must return. If the time limit is breached, a dialog is generated by the system informing the user that the application has become unresponsive and offering the choices of terminating it or waiting for it to respond. This dialog is called the ANR (Application Not Responding) dialog and should never appear in a well-written application. It is imperative that all event handlers always return quickly and any long-running operation is performed in a separate thread.



The ANR

LoaderManager and CursorLoader

The LoaderManager and CursorLoader classes provide the ability of running a database query in the background and updating the user interface when the query completes. The cursor is automatically requeried and the UI updated when there is a change in the database that may affect the query. The LoaderManager class also handles the activity lifecycle by automatically requerying the cursor when there is a configuration change.

Sync Adapters

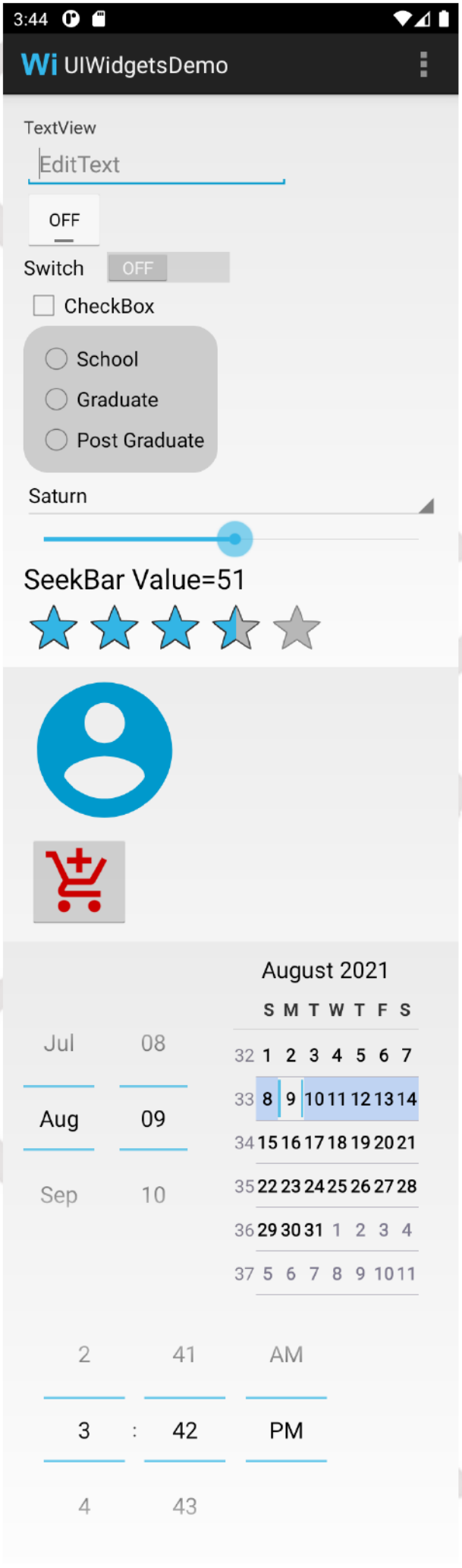
The sync adapter component in your app encapsulates the code for the tasks that transfer data between the device and a server. Based on the scheduling and triggers you provide in your app, the sync adapter framework runs the code in the sync adapter component. To add a sync adapter component to your app, you need to add the following pieces:

- **Sync adapter class** A class that wraps your data transfer code in an interface compatible with the sync adapter framework
- **Bound Service** A component that allows the sync adapter framework to run the code in your sync adapter class
- **Sync adapter XML metadata file** A file containing information about your sync adapter. The framework reads this file to find out how to load and schedule your data transfer
- **Declarations in the app manifest** XML that declares the bound service and points to sync adapter-specific metadata

Some Commonly Used Views

- **TextView** An uneditable view for displaying text
- **EditText** An editable view for displaying and editing text
- **ImageView** A view that displays an image
- **CheckBox** A box that can be checked or unchecked
- **RadioGroup** A group of radio buttons. It is also a LinearLayout with vertical orientation. The RadioButton views must be direct descendants (children) of the RadioGroup
- **RadioButton** A button that may be selected or unselected. Out of all the radio buttons in a RadioGroup, at most one button can be in selected state at any point in time. Thus, selecting one radio button automatically deselects all other in the same group. The RadioButton views must be direct descendants (children) of the RadioGroup
- **ToggleButton** A button that may be in either on or off state at any point in time
- **Switch** A Switch is a two-state toggle switch widget that can select between two options. The user may drag the "thumb" back and forth to choose the selected option, or simply tap to toggle as if it were a checkbox
- **Spinner** A dropdown list of items from which one item is selected

- **RatingBar** A view that allows the user to rate something in terms of "stars" (⭐).
- **Button** A button that can be clicked to invoke an event handler
- **ImageButton** A button with an image on it instead of text
- **ListView** A view holding a scrollable list of list items
- **DatePicker** A view used for input of a date
- **TimePicker** A view used for input of a time value
- **ScrollView** An invisible ViewGroup that permits scrolling of its contents when necessary. It can have exactly one child view, but the child view can be a ViewGroup or a Layout holding many views


3:44
UIWidgetsDemo
TextView
EditText
OFF
Switch
OFF
CheckBox
School
Graduate
Post Graduate
Saturn
SeekBar Value=51
August 2021
S M T W T F S
Jul 08
Aug 09
Sep 10
2 41 AM
3 : 42 PM
4 43

Display Contents

UIWidgetsDemo

Some Commonly Used Layouts

- **LinearLayout** A LinearLayout arranges all child views in sequentially along a dimension (vertical or horizontal) according to its orientation property. A LinearLayout with vertical orientation arranges all child views vertically one below another. A LinearLayout with horizontal orientation arranges all child views horizontally one after another
- **ConstraintLayout** A ConstraintLayout is a highly flexible layout that allows us to create even large and complex layouts with a flat view hierarchy, i.e. without the need to use nested layouts (layout inside layout). This improves the performance of the process of lay out inflation and, hence, the overall peefrmance of the app A constraint layout places all child views in the upper left corner by default. However, we specify constraints on the child views that are used to determine their position. Each constraint represents a connection or alignment to another view, the parent layout, or an invisible guideline. Every view has four edges - top, bottom, start (left) and end (right). We may attach an edge of a view with an edge of another view, an edge of a parent view or a guideline. These connections determine the position of the view
- **RelativeLayout** A RelativeLayout allows the designer to specify the positions of each child view in relation to either another child view or the parent view. For example, a view's vertical position may be aligned to the top of the parent view or below a sibling view. Similarly, a view's horizontal position may be aligned to the left of the parent view or to the right of a sibling view
- **TableLayout** A layout that consists of vertically organized TableRow objects. Each TableRow consists of horizontally organized views (cells). The height and width of the cells are adjusted automatically to make the overall layout look like a table, with each column having equal width.
- **FrameLayout** FrameLayout is designed to block a specific area of the screen to display a single item or a stack of items. If there are multiple child views inside the FrameLayout, then they are pushed onto a stack in the order in which they are defined. The stack of views is rendered (drawn) from the bottom of the stack, so that the top of the stack view is on the top.

The size of the FrameLayout is the size of its largest child (plus padding)

Some Commonly used Android Permissions

With Android, to access hardware (sensors), network, or to perform certain sensitive tasks, an app needs to request permission in its manifest file as follows:

```
<uses-permission android:name="android.permission.SEND_SMS" />
<uses-permission android:name="android.permission.RECEIVE_SMS" />
```

Permission	Use
`INTERNET`	Allows the use of the local network as well as the Internet
`ACCESS_COARSE_LOCATION`	Obtain rough location from the network provider
`ACCESS_FINE_LOCATION`	Obtain precise location using GPS (and A-GPS, if its is available
`ACCESS_NETWORK_STATE`	Allows applications to access information about networks
`CAMERA`	Required to be able to access the camera device
`GET_ACCOUNTS`	Allows access to the list of accounts in the Accounts Service
`BLUETOOTH`	Allows applications to connect to paired Bluetooth devices
`CAMERA`	Required to be able to access the camera device
`FLASHLIGHT`	Allows access to the flashlight
`READ_CONTACTS`	Allows an application to read the user's contacts data

Permission	Use
`READ_EXTERNAL_STORAGE`	Allows an application to read from external storage
`READ_SMS`	Allows an application to read SMS messages
`SEND_SMS`	Allows an application to send SMS messages
`WRITE_EXTERNAL_STORAGE`	Allows an application to write to external storage

Android Activity Lifecycle

An Android application may consists of a number of activities. Each activity is a single user interface screen. One activity may invoke another activity. Android maintains an Activity Stack. The activity that the user is currently interacting with is always at the top of the Activity Stack. When that activity starts another activity, the newly started activity is pushed on the top of the stack. When the newly started activity finishes, it is popped from the Activity Stack, bringing the previous activity to the top of the stack again.

The lifecycle of activities is managed by the Android system itself. To conserve scarce resources, especially battery power and memory, Android may terminate a running activity at any time. The activity is supposed to save its state when an event signaling the possibility of such termination occurs. When the activity is restarted, it is passed the previously saved state as a Bundle. The activity should use it to restore itself such that the user has a seamless experience and does not realize that the activity was terminated and restarted in-between. An activity may also be terminated and restarted when a configuration change, especially a change in the screen orientation or the locale, occurs.

At any time, an activity may be in one of the following states:

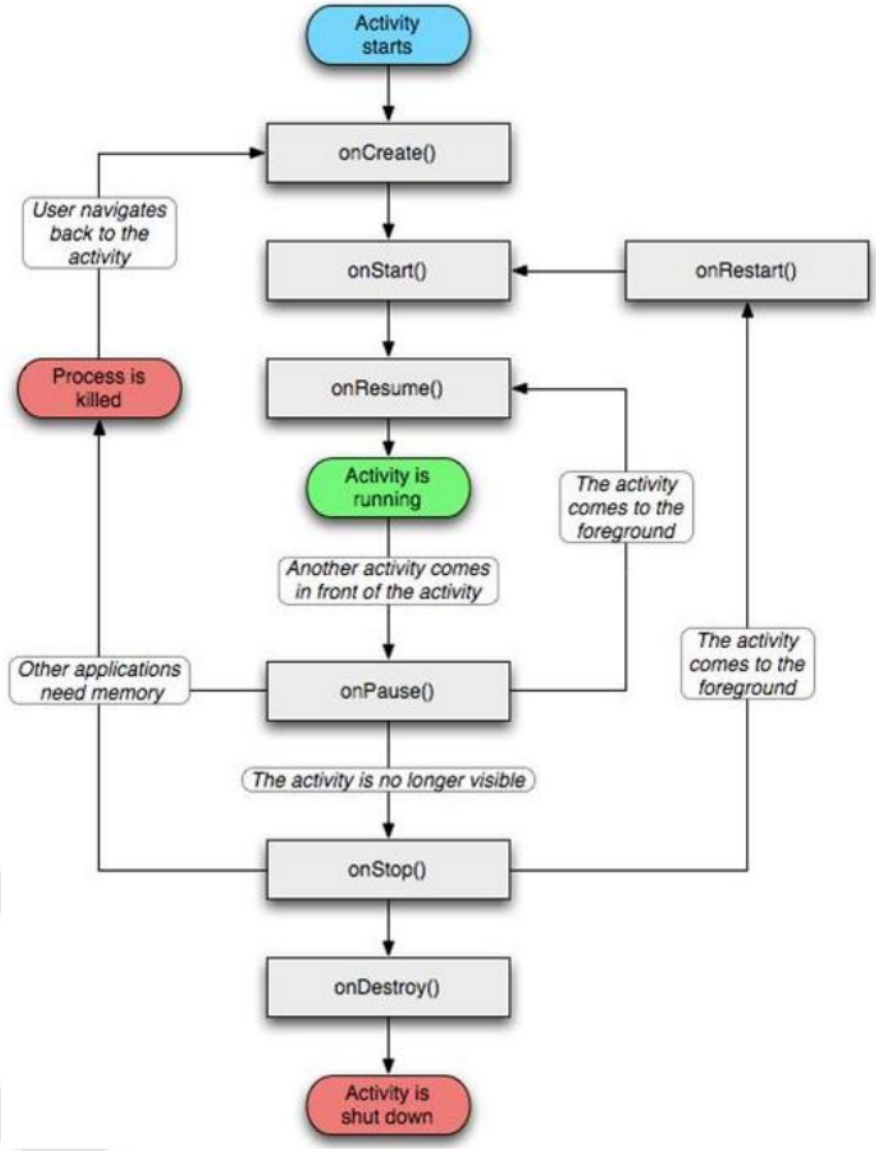
- **Resumed (Running)** An activity in this state is currently interacting with the user and has user focus in it. It is on the top of the Activity Stack. Such activity must continue running and update the UI and accept user input when needed, so it is never killed automatically by the Android system
- **Paused** An activity in this state is not currently interacting with the user and does not have user focus in it. It is not on the top of the Activity Stack. However, because the top-of-the-stack activity does not occupy the whole screen, this activity is at least partially visible. It is desirable to keep such an

activity running and updating its UI, so such activity is killed automatically by the Android system only as a last resort

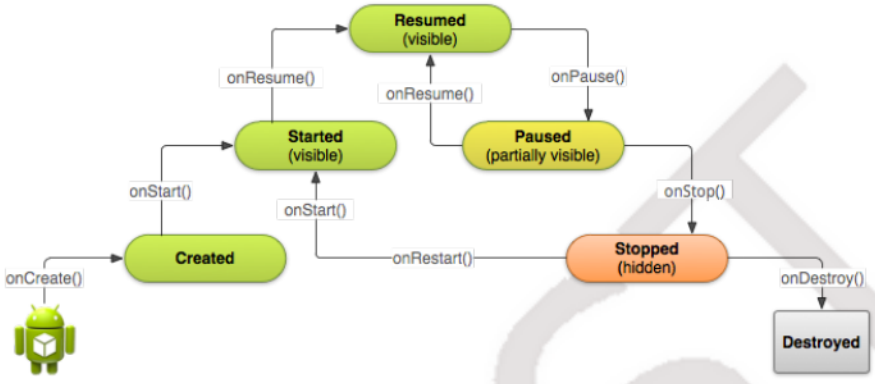
- **Stopped** An activity in this state is completely obscured by another activity (hidden behind that activity). While it may need to preserve its state (e.g. display), there is no need to waste CPU cycles on keeping it running. Such activity may be killed automatically by the Android system at any time

There are three loops in the lifecycle of an activity:

- **The entire lifetime** of an activity happens between the first call to `onCreate(Bundle)` through to a single final call to `onDestroy()`. An activity will do all setup of "global" state in `onCreate()`, and release all remaining resources in `onDestroy()`. For example, if it has a thread running in the background to download data from the network, it may create that thread in `onCreate()` and then stop the thread in `onDestroy()`
- **The visible lifetime** of an activity happens between a call to `onStart()` until a corresponding call to `onStop()`. During this time the user can see the activity on-screen, though it may not be in the foreground and interacting with the user. Between these two methods you can maintain resources that are needed to show the activity to the user. For example, you can register a BroadcastReceiver in `onStart()` to monitor for changes that impact your UI, and unregister it in `onStop()` when the user no longer sees what you are displaying. The `onStart()` and `onStop()` methods can be called multiple times, as the activity becomes visible and hidden to the user
- **The foreground lifetime** of an activity happens between a call to `onResume()` until a corresponding call to `onPause()`. During this time the activity is in front of all other activities and interacting with the user. An activity can frequently go between the resumed and paused states - for example when the device goes to sleep, when an activity result is delivered, when a new intent is delivered - so the code in these methods should be fairly lightweight



Android Activity Lifecycle



Android Activity Lifecycle

Android Activity Lifecycle Events

Method	Description	Activity Killable after	Possible Next Event

		this Event occurs?	
`onCreate()`	Called when the activity is first created. This is where you should do all of your normal static set up - create views, bind data to lists, and so on. This method is passed a Bundle object containing the activity's previous state, if that state was captured. Always followed by `onStart()`	No	`onStart()`
`onRestart()`	Called after the activity has been stopped, just prior to it being started again. Always followed by `onStart()`	No	`onStart()`
`onStart()`	Called just before the activity becomes visible to the user. Followed by `onResume()` if the activity comes to the foreground, or `onStop()` if it becomes hidden	No	`onResume()` or `onStop()`
`onResume()`	Called just before the activity starts interacting with the user. At this point the activity is at the top of the activity stack, with user input going to it. Always followed by `onPause()`	No	`onPause()`
`onPause()`	Called when the system is about to start resuming	Yes	`onResume()` or `onStop()`

	another activity. This method is typically used to commit unsaved changes to persistent data, stop animations and other things that may be consuming CPU, and so on. It should do whatever it does very quickly, because the next activity will not be resumed until it returns. Followed either by `onResume()` if the activity returns back to the front, or by `onStop()` if it becomes invisible to the user		
`onStop()`	Called when the activity is no longer visible to the user. This may happen because it is being destroyed, or because another activity (either an existing one or a new one) has been resumed and is covering it. Followed either by `onRestart()` if the activity is coming back to interact with the user, or by `onDestroy()` if this activity is going away	Yes	`onRestart()` or `onDestroy()`
`onDestroy()`	Called before the activity is destroyed. This is the final call that the activity will receive. It could be called either because the activity is finishing (someone called `finish()` on it), or	Yes	None

	because the system is temporarily destroying this instance of the activity to save space. You can distinguish between these two scenarios with the `isFinishing()` method		

Saving and Restoring Activity State

Activity state is saved in a Bundle, which implements the Parcelable interface. Items are stored in the bundle as key-value pairs. The interface provides methods like `putInt()`, `putChar()`, `putFloat()` and `putString()` to put items into the bundle and methods like `getInt()`, `getChar()`, `getFloat()` and `getString()` to get items from the bundle.

Activity state can be saved when `onPause()` is called and restored when `onCreate()` is called. However, Android provides dedicated events for saving and restoring the activity state. Activity state should be saved when `onSaveInstanceState()` is called. The method is passed a bundle in which to put the state. Android takes care of storing the bundle and passing it back to the activity when it is recreated. When an activity is created, the bundle is passed to both the `onCreate()` and `onRestoreInstanceState()` methods. The activity state can be restored in either of these events. If the passed bundle is null, it means the activity is starting afresh.

Go to *Activities*

Android Demonstration Projects List

Android Demonstration Projects List

	Project	Description
1	FirstApp	Project generated by the wizard, Project structure, Layout inflation, Accessing views, Writing event handlers, Logging messages
2	ActivityLifecycleDemo1	Demonstration of Activity life cycle
3	UIWidgetsDemo	Demonstration of common views

	Project	Description
4	LayoutsDemo	Demonstration of common layouts
5	MenuDemo	Demonstration of option menus
6	ImplicitIntentDemo	Using implicit intents
7	MyContacts1	ListView with adapter based on ArrayList, Menu, Context menu, Toast
8	MyContacts4	AlertDialog, Intents, Invoking other activity using intent, Passing data through intent, Returning results from activity, Database access, EDT (Event Dispatch Thread), LoaderManager, LoaderCallbacks, CursorLoader, ContentProvider, Custom list item layout
9	EmployeeManagement6	Creating icon sets, Providing different resources according to device configuration, Constructing layout programmatically, Internationalization
10	Contacts2	Fetching Android contacts using built-in content provider
11	Notification1	Creating notifications, Notification buttons, PendingIntent
12	HTTPRequest2	Making asynchronous requests using AsyncTask, Making HTTP POST request
13	MediaClient	Listing files from server, Downloading files from server and opening them with implicit intent
14	FileUpload	Uploading a file to the server using HTTP POST
15	HandleIntentTextHTML	Defining an intent filter, Opening an HTML file when invoked through implicit intent

	Project	Description
16	HandleIntentTextImage	Defining an intent filter, Displaying an image when invoked through implicit intent
17	SMS1	Sending and receiving text messages
18	CallLogExample1	Detecting phone state changes, Accessing the built-in call log, Generating notifications for calls made, received and missed
19	Animation1	Creating animation
20	Animations	Example of animations
21	GeoLocationService1	Android background services, Determining the location using GPS and AGPS
22	LocationAwareness1	An example of a location-aware app
23	CaptureImageFromCamera1	To capture an image from camera from inside our app by invoking the camera app using an intent

Annotated Code Snippets

Basic Activity Structure

```
public class MainActivity extends Activity
{

    @Override
    protected void onCreate(Bundle savedInstanceState)
    {
        // With many Android event handlers, one must call the
        parent class handler
        // before (or, with some events, after) one's own code
        super.onCreate(savedInstanceState);
        // Inflate the layout
        setContentView(R.layout.activity_main);
    }
```

```
    @Override
    public boolean onCreateOptionsMenu(Menu menu)
    {
        // Inflate the menu; this adds items to the action bar if
        it is present.
        getMenuInflater().inflate(R.menu.main, menu);
        return true;
    }

    @Override
    public boolean onOptionsItemSelected(MenuItem item)
    {
        return super.onOptionsItemSelected(item);
    }

}
```

Using different views (TextView example)

```
public TextView textViewMessage;
..
// In onCreate()
..
textViewMessage = (TextView)findViewById(R.id.textViewMessage);
..
textViewMessage.setText("Welcome ");
```

Displaying a Toast

```
// Don't forget to show the created Toast!
Toast.makeText(context, "Settings not implemented yet",
                                        Toast.LENGTH_LONG).show();
```

Using a Button

```
public Button buttonOK;
..
// In onCreate()...
buttonOK = (Button)findViewById(R.id.buttonOK);
buttonOK.setOnClickListener(new View.OnClickListener()
{
      @Override
      public void onClick(View view)
      {
          ..
```

```
            ..
        }
});
```

Using menus

```
@Override
public boolean onCreateOptionsMenu(Menu menu)
{
    // Inflate the menu; this adds items to the action bar if it
        is present.
    getMenuInflater().inflate(R.menu.main, menu);
    return true;
}

@Override
public boolean onOptionsItemSelected(MenuItem item)
{
      int menuId = item.getItemId();
      switch(menuId)
      {
          case R.id.menu_1:
            ..
            break;
          case R.id.menu_2:
            ..
            break;
       }
   return super.onOptionsItemSelected(item);
}
```

Showing and Hiding a View

```
textViewEmail.setVisible(View.VISIBLE);
textViewEmail.setVisible(View.GONE);
```

Enabling and Disabling a View

```
textViewEmail.setEnabled(true);
textViewEmail.setEnabled(false);
```

Using the Context Menu

```
// in onCreate()
registerForContextMenu(listViewContactName);

@Override
public void onCreateContextMenu(ContextMenu menu, View v,
                                    ContextMenuInfo menuInfo)
{
     getMenuInflater().inflate(R.menu.contact_list_context_menu,
        menu);
     super.onCreateContextMenu(menu, v, menuInfo);
}

@Override
public boolean onContextItemSelected(MenuItem item)
{
    AdapterContextMenuInfo info = (AdapterContextMenuInfo)
        item.getMenuInfo();
    int itemId = item.getItemId();
    switch(itemId)
    {
        case R.id.edit_contact:
        ..
        break;
        case R.id.delete_contact:
        ..
        break;
     }
     return super.onContextItemSelected(item);
}
```

Saving and Restoring Instance State

```
@Override
protected void onSaveInstanceState(Bundle outState)
{
    // The contents of views with unique id
    // and user-editability are saved and restored
    // automatically by Android
    // No need to save and restore their state in our code
    // Just call the super class method
    outState.putString("editText3",
        editText3.getText().toString());
    outState.putString("textViewData",
        textViewData.getText().toString());
    super.onSaveInstanceState(outState);
}

@Override protected void onRestoreInstanceState(Bundle
        savedInstanceState)
```

```
{
    editText3.setText(savedInstanceState.getString("editText3"));
    textViewData.setText(savedInstanceState.getString("textViewData"
    // Don't forget to call the super class method
    super.onRestoreInstanceState(savedInstanceState);
}
```

Creating a Confirmation Dialog

```
private void confirm(String message, String okButtonText, String
        cancelButtonText
{
    Context context = this;
    String title = "Confirmation";
    final AlertDialog.Builder builder = new
        AlertDialog.Builder(context);
    builder.setTitle(title);
    builder.setMessage(message);
    // Use builder.setPositiveButton() to set the "Positive" (OK
        or YES) button
    // Use builder.setNegativeButton() to set the "Negative"
        (Don't or No) button
    // To permit dismissal of the dialog without pressing a
        button (using back button)
    // builder.setCancelable(true);
    // Use builder.setOnCancelListener() to set the action to be
        taken when
    //                                the dialog is cancelled

    AlertDialog ad = builder.create();
    // Don't forget to show the created dialog!
    ad.show();
}
```

Using Fragments

```
// activity_main.xml (layout file for MainActivity)
<?xml version="1.0" encoding="utf-8"?>
<androidx.constraintlayout.widget.ConstraintLayout
        xmlns:android="http://schemas.android.com/apk/res
        /android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".MainActivity">

    <Button
```

```
        android:id="@+id/buttonFirstFragment"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        app:layout_constraintTop_toTopOf="parent"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintEnd_toStartOf="@id/buttonSecondFragment
        android:text="@string/first_fragment"
        />

    <Button
        android:id="@+id/buttonSecondFragment"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        app:layout_constraintTop_toTopOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintStart_toEndOf="@id/buttonFirstFragment"
        android:text="@string/second_fragment"
        />

    <FrameLayout
        android:id="@+id/frameLayout1"
        android:layout_width="match_parent"
        android:layout_height="0dp"
        app:layout_constraintTop_toBottomOf="@id/buttonFirstFragment
        app:layout_constraintBottom_toBottomOf="parent"
        />

</androidx.constraintlayout.widget.ConstraintLayout>
```

```
// fragment_first.xml (layout file for FirstFragment)
<?xml version="1.0" encoding="utf-8"?>
<FrameLayout xmlns:android="http://schemas.android.com/apk/res
        /android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".FirstFragment">

        <ImageView
            android:layout_width="match_parent"
            android:layout_height="match_parent"
            android:src="@drawable/isro_eos_sat"
            />

</FrameLayout>
```

```
// fragment_second.xml (layout file for SecondFragment)
<?xml version="1.0" encoding="utf-8"?>
```

```
<FrameLayout xmlns:android="http://schemas.android.com/apk/res
        /android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".SecondFragment">

        <ImageView
            android:layout_width="match_parent"
            android:layout_height="match_parent"
            android:src="@drawable/spacewalks_x675"
            />

</FrameLayout>
```

```
// FirstFragment.java
package org.gdcst.jigneshsmart.fragmentdemo;

import android.app.Fragment;

import android.view.LayoutInflater;
import android.view.View;
import android.view.ViewGroup;

public class FirstFragment extends Fragment {

    public FirstFragment() {
        // Required empty public constructor
    }

    public static FirstFragment newInstance() {
        return new FirstFragment();
    }

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
    }

    @Override
    public View onCreateView(LayoutInflater inflater, ViewGroup
        container,
                             Bundle savedInstanceState) {
        // Inflate the layout for this fragment
        return inflater.inflate(R.layout.fragment_first,
        container, false);
    }
}
```

```java
// SecondFragment.java
package org.gdcst.jigneshsmart.fragmentdemo;

import android.app.Fragment;

import android.view.LayoutInflater;
import android.view.View;
import android.view.ViewGroup;

public class SecondFragment extends Fragment {

    public SecondFragment() {
        // Required empty public constructor
    }

    public static SecondFragment newInstance() {
        return new SecondFragment();
    }

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        }
    }

    @Override
    public View onCreateView(LayoutInflater inflater, ViewGroup
        container,
                             Bundle savedInstanceState) {
        // Inflate the layout for this fragment
        return inflater.inflate(R.layout.fragment_second,
        container, false);
    }
}
```

```java
// MainActivity.java
package org.gdcst.jigneshsmart.fragmentdemo;

import androidx.appcompat.app.AppCompatActivity;

import android.app.Fragment;
import android.app.FragmentManager;
import android.app.FragmentTransaction;
import android.view.View;
import android.widget.Button;

public class MainActivity extends AppCompatActivity {

    Button buttonFirstFragment;
    Button buttonSecondFragment;
```

```
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
        buttonFirstFragment =
        findViewById(R.id.buttonFirstFragment);
        buttonSecondFragment =
        findViewById(R.id.buttonSecondFragment);

        buttonFirstFragment.setOnClickListener(new
        View.OnClickListener() {
            @Override
            public void onClick(View v) {
                Fragment fragment = FirstFragment.newInstance();
                loadFragment(fragment);
            }
        });

        buttonSecondFragment.setOnClickListener(new
        View.OnClickListener() {
        @Override
        public void onClick(View v) {
            Fragment fragment = SecondFragment.newInstance();
            loadFragment(fragment);
            }
        });

    }

    private void loadFragment(Fragment fragment)
    {
        //create fragment Manager
        FragmentManager fragmentManager = getFragmentManager();
        // create fragment transaction
        FragmentTransaction fragmentTransaction =
        fragmentManager.beginTransaction();
        //replace the FrameLayout with the new Fragment
        fragmentTransaction.replace(R.id.frameLayout1, fragment);
        fragmentTransaction.commit();
    }

}
```

Using an ArrayAdapter

```
public static ArrayList<String> contacts;
public static ArrayAdapter<String> adapterContacts;
contacts = new ArrayList<String>();
adapterContacts =
```

```
        new ArrayAdapter<String>(context,
             android.R.layout.simple_list_item_1, contacts);
listViewContactName.setAdapter(adapterContacts);
contacts.add("aaa");
contacts.add("bbb");
adapterContacts.notifyDataSetChanged();
```

Invoking a Fixed Activity Using Intent

```
Intent editContactDetails = new Intent(context,
        ContactDetails.class);

// If activity result is needed
startActivityForResult(editContactDetails, 1);
// Result would be Activity.RESULT_OK or Activity.RESULT_CANCELED

// If result is not needed
// startActivity(editContactDetails);

// To process activity result
@Override
protected void onActivityResult(int requestCode, int resultCode,
        Intent data)
{
    super.onActivityResult(requestCode, resultCode, data);
    switch(requestCode)
    {
        case (1):
            if (resultCode == Activity.RESULT_OK)
            ..
            else if (resultCode == Activity.RESULT_CANCELED)
            ..
            break;
    }
}
```

Communicating Data Through Intent

```
Intent editContactDetails = new Intent(context,
        ContactDetails.class);

// Optionally pass additional information through the intent
editContactDetails.putExtra("action", 1);
editContactDetails.putExtra("selectedContactName", "abc");

// Retreiving extra data from intent
// In ContactDetails class
```

```
// If the key is not found, -1 is returned
int action = getIntent().getIntExtra("action", -1);

// If the key is not found, null is returned
selectedContactName =
        getIntent().getStringExtra("selectedContactName");
```

The DatabaseOpenHelper Class

```
public class ContactDatabaseOpenHelper extends SQLiteOpenHelper
{
    private static final String DATABASE_NAME = "contacts.db";
    private static final int DATABASE_VERSION = 1;

    // Database creation SQL statement
    private static final String DATABASE_CREATE =
                "create table contacts (
                id integer primary key autoincrement,
                name text unique not null,
                phone text not null,
                email text,
                birthdate date);";

    public ContactDatabaseOpenHelper(Context context)
    {
        super(context, DATABASE_NAME, null, DATABASE_VERSION);
    }

    @Override
    public void onCreate(SQLiteDatabase database)
    {
        database.execSQL(DATABASE_CREATE);
    }

    @Override
    public void onUpgrade(SQLiteDatabase database, int
        oldVersion, int newVersio
    {
        // We should have backed up the data for restoration
        after the upgrade
        database.execSQL("DROP TABLE IF EXISTS contacts");

        // Recreate the table
        onCreate(database);
    }
}
```

ContentProvider

```
// Only few key components
public class ContactsContentProvider extends ContentProvider
{
    private ContactDatabaseOpenHelper dbOpenHelper;

    @Override
    public boolean onCreate()
    {
        dbOpenHelper = new
        ContactDatabaseOpenHelper(getContext());
        return false;
    }

    public Cursor query(Uri uri, String[] projection, String
        selection,
                                String[] selectionArgs, String
        sortOrder)
    {
        // Execute the query and return a cursor
    }

    @Override
    public Uri insert(Uri uri, ContentValues values)
    {
        // ContentValues consists of key-value pairs
        // The key is the column name
        // The value is the value to be inserted in that column
        // Perform an insert query using them
        // Return a URI to the newly created row
    }

   @Override
   public int update(Uri uri, ContentValues values, String
        selection,
                                                String[]
        selectionArgs)
   {
        // selection contains the where clause
        // selectionArgs contains the parameters to the where
        clause
        // Perform the update query and return number of rows
        updated
   }

   @Override
   public int delete(Uri uri, String selection, String[]
        selectionArgs)
   {
        // Delete the rows as per the where clause
        // specified in selection and selectionArgs
```

```
        // Return the number of rows
    }
}
```

An Example of LoaderManager, CursorLoader and SimpleCursorAdapter

```
public class MainActivity extends Activity implements
        LoaderCallbacks<Cursor>
{
    @Override
    protected void onCreate(Bundle savedInstanceState)
    {
        listViewContacts.setVisibility(View.INVISIBLE);
    fillData();
    }

    @Override
    public Loader<Cursor> onCreateLoader(int id, Bundle args)
    {
        String[] projection =
        ContactDatabaseOpenHelper.allColumns;
        CursorLoader cursorLoader = new CursorLoader(this,
            ContactsContentProvider.CONTENT_URI, projection,
        null, null,

        ContactDatabaseOpenHelper.COLUMN_NAME);
        return cursorLoader;
    }

    @Override
    public void onLoadFinished(Loader<Cursor> loader, Cursor
        data)
    {
        adapterContacts.swapCursor(data);
        listViewContacts.setVisibility(View.VISIBLE);
    }

    @Override
    public void onLoaderReset(Loader<Cursor> loader)
    {
        adapterContacts.swapCursor(null);
    }

    private void fillData()
    {
        String[] from = new String[] {
        ContactDatabaseOpenHelper.COLUMN_NAME,
        ContactDatabaseOpenHelper.COLUMN_ID}; // ID is MUST!
        // Fields on the UI to which we map
```

```
        int[] to = new int[] { R.id.textViewListViewItem };
        getLoaderManager().initLoader(0, null, this);
        adapterContacts = new SimpleCursorAdapter(this,
        R.layout.listview_layout,
                                        null, from, to, 0);
        listViewContacts.setAdapter(adapterContacts);
    }
}
```

Retrieving an Image from a URI

```
InputStream inputStream =
        context.getContentResolver().openInputStream(contentUri);
Bitmap receivedBitmapImage =
        BitmapFactory.decodeStream(inputStream);
```

Making HTTP GET Request

```
URL url = new URL(urlString);
HttpURLConnection conn = (HttpURLConnection)
        url.openConnection();
conn.setReadTimeout(10000 /* milliseconds */);
conn.setConnectTimeout(15000 /* milliseconds */);
conn.setRequestMethod("GET");
conn.setDoInput(true);
conn.connect();
int responseCode = conn.getResponseCode();
if (responseCode == HttpURLConnection.HTTP_OK)
{
    is = conn.getInputStream();
    // Convert the InputStream into a string
    BufferedReader br = null;
    br = new BufferedReader(new InputStreamReader(is, "UTF-8"));
    StringBuilder sb = new StringBuilder();
    String line;
    while ((line = br.readLine()) != null)
    {
        sb.append(line).append('\n');
    }
    responseString = sb.toString();
}
else
{
    responseString = "HTTP GET request for " + urlString +
                " returned status " + responseCode;
}
```

Making HTTP POST Request

```
HttpURLConnection conn = (HttpURLConnection)
        url.openConnection();
conn.setReadTimeout(15000);
conn.setConnectTimeout(15000);
conn.setRequestMethod("POST");
conn.setDoInput(true);
conn.setDoOutput(true);
os = conn.getOutputStream();
BufferedWriter writer =
new BufferedWriter(new OutputStreamWriter(os, "UTF-8"));
writer.write(postData);
writer.flush();
writer.close();
os.close();
int responseCode = conn.getResponseCode();
if (responseCode == HttpURLConnection.HTTP_OK)
{
    String line;
    BufferedReader br = new BufferedReader(new InputStreamReader(
                                    conn.getInputStream()));
    while ((line = br.readLine()) != null)
    {
        responseString += line;
    }
}
else
{
    responseString = "HTTP POST request for " + urlString +
                     " returned status " +
                     responseCode;
}
```

Using the AsyncTask Class for Performing Asynchronous Operations

```
// Note: AsyncTask is a generic class
// The first type argument (Object in this example) determines
        the type of
// parameters array passed to doInBackground
// The second type argument, if not Void, is used for displaying
        progress
// The third type argument indicates the return type of
        doInBackground
// and the argument type of onPostExecute()
// AsyncTask is an abstract class and must be extended for use
```

```
public class AsyncGetRequest extends AsyncTask<Object, Void,
        String>
{
    @Override
    protected void onPreExecute()
    {
        // Called before running the background task
        // Runs on the UI thread
        // May be used to initiate a progress display
    }

    @Override
    protected String doInBackground(Object... params)
    {
        // Runs in a background thread
        // params is an array
        // Must not access the UI
    }

    protected void onPostExecute(String result)
    {
        // Called when the background task is over
        // result is the return value from doInBackground
        // Runs on the UI thread
        // May access the UI
    }
}

// Invoking the above class
String url = "http://10.0.2.2/androidhttp/getList.php";
// Even for passing one argument, we need an array
Object[] params = new String[] {url};
AsyncGetRequest getRequest = new AsyncGetRequest();
getRequest.execute(params);
```

Opening a File using Implicit Intent

```
// Open the file by requesting Android to do it
// Use of implicit
Intent Intent intent = new Intent();
Uri uri = Uri.parse("file://"+directoryPath+"/"+fileName);
intent.setDataAndType(uri, mimeType);
startActivity(intent);
```

Creating a Notification

```
public static final String MISSED_CALL_CHANNEL = "Missed Call";
```

```
int notificationId = 123;

final NotificationManager notificationManager =
        (NotificationManager)
        getSystemService(NOTIFICATION_SERVICE);
Notification.Builder notificationBuilder;
if (Build.VERSION.SDK_INT < Build.VERSION_CODES.O) {
    notificationBuilder = new Notification.Builder(this);
} else {
    createNotificationChannel();
    notificationBuilder = new Notification.Builder(this,
        MISSED_CALL_CHANNEL);
}
notificationBuilder.setContentTitle("Missed Call");
notificationBuilder.setContentText("You have a missed call from
        Xyz");
notificationBuilder.setSmallIcon(R.drawable.ic_notification_missed_c
Notification notification = notificationBuilder.build();
// notificationId is an integer id unique for this type of
        notifications
notificationManager.notify(notificationId, notification);

    ...

private void createNotificationChannel() {
    // Create the NotificationChannel, but only on API 26+
        because
    // the NotificationChannel class is new and not in the
        support library
    if (Build.VERSION.SDK_INT >= Build.VERSION_CODES.O) {
        CharSequence name = "Missed Call Channel";
        String description = "First notification channel for
        testing";
        int importance = NotificationManager.IMPORTANCE_DEFAULT;
        NotificationChannel channel = new
        NotificationChannel(MISSED_CALL_CHANNEL, name,
        importance);
        channel.setDescription(description);
        // Register the channel with the system; you can't change
        the importance
        // or other notification behaviors after this
        NotificationManager notificationManager =
        getSystemService(NotificationManager.class);
        notificationManager.createNotificationChannel(channel);
    }
}
```

Services

A Service is an application component that can perform long-running operations in the background and does not provide a user interface. Another application

component can start a service and it will continue to run in the background even if the user switches to another application. Additionally, a component can bind to a service to interact with it and even perform interprocess communication (IPC). For example, a service might handle network transactions, play music, perform file I/O, or interact with a content provider, all from the background.

A service may be use in two ways:
A service is "started" when an application component (such as an activity) starts it by calling *startService()*. Once started, a service can run in the background indefinitely, even if the component that started it is destroyed. Usually, a started service performs a single operation and does not return a result to the caller. For example, it might download or upload a file over the network. When the operation is done, the service should stop itself. A service is "bound" when an application component binds to it by calling *bindService()*. A bound service offers a client-server interface that allows components to interact with the service, send requests, get results, and even do so across process boundries with inter-process communication (IPC). A bound service runs only as long as another application component is bound to it. Multiple components can bind to the service at once, but when all of them unbind, the service is destroyed.

The same service can work both ways - it can be started (to run indefinitely) and also allow binding. It's simply a matter of which of the callback methods are implemented: Implement *onStartCommand()* to allow components to start it, *onBind()* to allow binding and both to allow both ways of working.

The Android system will force-stop a service when memory is low and it must recover system resources for the activity that has user focus. If the service is bound to an activity that has user focus, then it is less likely to be killed. If the system kills your service, it restarts it as soon as resources become available again if *onStartCommand()* returned START_STICKY.

A services runs in the same process as the application in which it is declared and in the main thread of that application, by default. So, if your service performs intensive or blocking operations while the user interacts with an activity from the same application, the service will slow down activity performance. To avoid impacting application performance, you should start a new thread inside the service.

The *bindService()* method in the invoking activity requires an object of the ServiceConnection class. This object allows us to handle service related events like *onServiceConnected()* and *onServiceDisconnected()*. If we pass the flag

Context.BIND_AUTO_CREATE, the service will be automatically created if it is not already running.

Code to Bind to a Service

```
Intent intent = new Intent(context, LocationService.class);
bindService(intent, serviceConnection, Context.BIND_AUTO_CREATE);
```

Code to Unbind from a Service

```
unbindService(serviceConnection);
```

Service Implementation Template

```
public class LocationService extends Service
{
    public void onCreate();
    public int onStartCommand(Intent intent, int flags, int
        startId);
    public IBinder onBind(Intent intent);
    public boolean onUnbind(Intent intent);
    public void onDestroy();
}
```

Geolocation

Geolocation means finding the current location of the user. This information can be used for geotagging photographs (adding information of the location to a photograph), displaying maps, finding directions, in various location aware applications that display content according to the location of the user, etc.

There are two primary ways of geolocation. A mobile device in an urban area can usually receive signals from multiple mobile towers and measure their relative signal strength. This can be used along with information about the physical locations of the towers and trigonometry in complicated algorithms to estimate the position of the mobile device. The accuracy of this method is obviously very limited and highly variable. This method is called network-based geolocation and location information thus obtained is called coarse (grained) location. The other method is to use GPS (Global Positioning System). GPS has 24 satellites orbiting the planet. At any time, at any place, a mobile device can receive signals from at least 4 of these satellites if there are no obstructions.

This is enough to determine the location of a user with an accuracy of few meters. Location obtained this way is called fine (grained) location. The mobile device must have a GPS receiver, which most smartphones do. The GPS signals are too weak indoors to be useful, which is a major limitation of the system. Another issue is that the mobile receiver takes several minutes to locate the satellites. This problem is solved using A-GPS (Assisted GPS), where the coarse location obtained using the network-based method is used along with known algorithms for finding the approximate location of the satellites at that place at that time. Once the satellites are found, GPS can provide fine-grained location.

The network method incurs some data charges on the mobile device as it communicates with the mobile towers. The GPS method is completely free as the signals are broadcast by the satellites over a wide area and all devices in the area receive and use them.

Geolocation or geopositioning has many uses; including finding one's location in an unknown place, sending the user's current location to emergency service, mapping, providing directions for travel, location-aware apps, etc. Location-aware apps work by finding the device's current location and delivering results depending on it. For example, location-aware apps may provide information about the nearest ATM, nearby restaurants/hospitals/doctors, movie halls/multiplexes, currently running movies, shopping malls, tourist attractions, etc. A location-aware app can also notify the user when a person in their contact list is in a nearby area. Geolocation is also used for geotagging, wherein the location where a photograph is taken is recorded as meta data in the photograph itself.

Checking Whether Network and GPS Providers are Available or Not

```
locationManager = (LocationManager)
        getSystemService(Context.LOCATION_SERVICE);
isAvailableNetworkProvider = locationManager

        .isProviderEnabled(LocationManager.NETWORK_PROVIDER);
isAvailableGPSProvider = locationManager

        .isProviderEnabled(LocationManager.GPS_PROVIDER);
```

Location Listener Class

```
public class MyLocationListener implements LocationListener
{
   @Override
   public void onLocationChanged(final Location loc)
   {
       double latitude = loc.getLatitude();
       double longitude = loc.getLongitude();
       double accuracy = loc.getAccuracy();
       String provider = loc.getProvider();
       Date timeOfLocationFix = new Date(loc.getTime());
       SimpleDateFormat simpleDateFormat = new SimpleDateFormat(
        "hh:mm:ss.SSSa")
       String timeOfLocationFixString =
        simpleDateFormat.format(timeOfLocationFix
       Log.i(TAG, "Latitude=" + latitude + " Longitude=" +
        longitude +
                       " Accuracy=" + accuracy + " Time of fix="
        +
                        timeOfLocationFixString + " Provider=" +
       provider);
    }

    @Override
    public void onProviderDisabled(String provider)
    {
    }

    @Override
    public void onProviderEnabled(String provider)
    {
    }

    @Override
    public void onStatusChanged(String provider, int status,
        Bundle extras)
    {
    }
}
```

Registering the Location Listener

```
listener = new MyLocationListener();
if (isAvailableNetworkProvider)
        locationManager.requestLocationUpdates(
                  LocationManager.NETWORK_PROVIDER, 4000, 0,
        listener);
if (isAvailableGPSProvider)
                  locationManager.requestLocationUpdates(
                  LocationManager.GPS_PROVIDER, 4000, 0,
        listener);
```

Unregistering the Location Listener

```
if (listener != null)
    locationManager.removeUpdates(listener);
```

Audio

In Android, any additional files can be stored in the raw subfolder under resources. The names of the files should be valid for resource ids (all lowercase, no space). All files in the folder are assigned ids like R.raw.filename. Note that the extension will not be part of the id. These ids can be used to access the file in code. The assets directory in Android works in a similar way, but is not a resource directory, hence no ids are assigned to files under the assets directory. We use the MediaPlayer class to play audio.

Audio should be played from a background service.

Android Code to Play an Audio File from the Raw Directory

```
public void playAudio(View view)
{
    Intent objIntent = new Intent(this, PlayAudio.class);
    startService(objIntent);
}

public void stopAudio(View view)
{
      Intent objIntent = new Intent(this, PlayAudio.class);
      stopService(objIntent);
}

public class PlayAudio extends Service
{

    MediaPlayer objPlayer;
    public void onCreate()
    {
        super.onCreate();
        objPlayer = MediaPlayer.create(this,R.raw.sleepaway);
    }

    public int onStartCommand(Intent intent, int flags, int
        startId)
    {
        objPlayer.start();
        if(objPlayer.isLooping() != true)
```

```
        {
            Log.d(LOGCAT, "Problem in Playing Audio");
        }
        return 1;
    }

    public void onStop()
    {
        objPlayer.stop();
        objPlayer.release();
    }

    public void onPause()
    {
        objPlayer.stop();
        objPlayer.release();
    }

    public void onDestroy()
    {
        objPlayer.stop();
        objPlayer.release();
    }

    @Override
    public IBinder onBind(Intent objIndent)
    {
        return null;
    }
}
```

Video

Video can be played in a similar way as audio. We use the VideoView class for playing video.

```
public class MainActivity extends Activity
{
    @Override
    protected void onCreate(Bundle savedInstanceState)
    {
        super.onCreate(savedInstanceState);
        getWindow().setFormat(PixelFormat.TRANSLUCENT);
        VideoView videoHolder = new VideoView(this);
        // if you want the controls to appear
        videoHolder.setMediaController(new
        MediaController(this));
        Uri video = Uri.parse("android.resource://" +
        getPackageName()
```

```
                                    + "/" +
            R.raw.milesurmeratumhara);
            videoHolder.setVideoURI(video);
            setContentView(videoHolder);
            videoHolder.start();
        }
}
```

Animation

Android supports three types of animations:

- **Property Animation:** Introduced in Android 3.0 (API level 11), the property animation system lets you animate properties of any object, including ones that are not rendered to the screen. The system is extensible and lets you animate properties of custom types as well
- **View Animation:** View Animation is the older system and can only be used for Views. It is relatively easy to setup and offers enough capabilities to meet many application's needs. There are two types of animations that can be created using this method
    - **Tween Animation:** Creates an animation by performing a series of transformations on a single image with an Animation
    - **Frame Animation:** creates an animation by showing a sequence of frames (images) in order with an AnimationDrawable
- **Drawable Animation:** Drawable animation involves displaying Drawable resources one after another, like a roll of film. This method of animation is useful if you want to animate things that are easier to represent with Drawable resources, such as a progression of bitmaps.

An Example of Motion Tweening

In motion tweening, an image is taken and a series of operations are performed on it one by one, each for the time duration specified. This can be done in XML or code. Our example uses an XML animation file to define the operations to be performed.

```
<!-- activity_main.xml -->
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res
        /android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
```

```
    android:orientation="vertical" >

    <TextView android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:text="@string/hello_world" />

    <ImageView android:id="@+id/ImageView01"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:src="@drawable/android_logo" />
</LinearLayout>
```

```
<!-- res/anim/hyperspace_jump.xml -->
<set xmlns:android="http://schemas.android.com/apk/res/android"

        android:shareInterpolator="false" >
    <scale android:duration="700"
        android:fillAfter="false"
        android:fromXScale="1.0"
        android:fromYScale="1.0"
        android:interpolator="@android:anim/accelerate_decelerate_in
        android:pivotX="50%"
        android:pivotY="50%"
        android:toXScale="1.4"
        android:toYScale="0.6" />

    <set
        android:interpolator="@android:anim/accelerate_interpolator"
                                    android:startOffset="700" >

        <scale android:duration="400"
            android:fromXScale="1.4"
            android:fromYScale="0.6"
            android:pivotX="50%"
            android:pivotY="50%"
            android:toXScale="0.0"
            android:toYScale="0.0" />

        <rotate android:duration="400"
            android:fromDegrees="0"
            android:pivotX="50%"
            android:pivotY="50%"
            android:toDegrees="-45"
            android:toYScale="0.0" />

    </set>

</set>
```

```
public class MainActivity extends Activity
{
    @Override
    public void onCreate(Bundle savedInstanceState)
    {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
        ImageView image = (ImageView)
        findViewById(R.id.ImageView01);
        Animation hyperspaceJump =
        AnimationUtils.loadAnimation(this, R.anim.hyper
        image.startAnimation(hyperspaceJump);
    }
}
```

The Telephony API

Android provides us almost full access to the system. The biggest example of this is that we may even initiate calls programmatically from our application as illustrated by the following example. We need the android.permission.CALL_PHONE permission for this.

```
 Intent callIntent = new Intent(Intent.ACTION_CALL);
callIntent.setData(Uri.parse("tel:0377778888"));
startActivity(callIntent);
```

Sending and Receiving Text Messages (SMS)

We use the class SmsManager for sending and receiving text messages. We need the android.permission.SEND_SMS and android.permission.RECEIVE_SMS permissions respectively. Receiving text messages also requires a broadcast receiver, which must be registered in the manifest. To test the application, create two different AVDs and start both of them at a time. The emulators run on particular TCP ports. The port number is displayed in the title bar of the window. It also doubles up as the telephone number for the emulator. On the receiver side, the message is received in a Bundle as a PDU (Protocol Data Unit). The method SmsMessage.createFromPdu is used to extract the message from the PDU.

```
<!-- AndroidManifest.xml ->
..
<uses-permission android:name="android.permission.SEND_SMS" />
<uses-permission android:name="android.permission.RECEIVE_SMS" />
```

```
..
<application
    ..
    <receiver android:name=".SMSReceiver" >
        <intent-filter>
            <action
        android:name="android.provider.Telephony.SMS_RECEIVED" />
        </intent-filter>
    </receiver>
    ..
</application>
```

```
// sends an SMS message to another device
private void sendSMS(String phoneNumber, String message)
{
    SmsManager sms = SmsManager.getDefault();
    sms.sendTextMessage(phoneNumber, null, message, null, null);
}
```

```
// Broadcast reciever for receiving SMS
public class SMSReceiver extends BroadcastReceiver
{
    @Override
    public void onReceive(Context context, Intent intent)
    {
        // ---get the SMS message passed in---
        Bundle bundle = intent.getExtras();
        SmsMessage[] msgs = null;
        String str = "";
        if (bundle != null)
        {
            // ---retrieve the SMS message received---
            Object[] pdus = (Object[]) bundle.get("pdus");
            msgs = new SmsMessage[pdus.length];
            for (int i = 0; i < msgs.length; i++)
            {
                msgs[i] = SmsMessage.createFromPdu((byte[])
        pdus[i]);
                str += "SMS from " +
        msgs[i].getOriginatingAddress();
                str += " :";
                str += msgs[i].getMessageBody().toString();
                str += "\n";
            }
            // ---display the new SMS message---
            Toast.makeText(context, str,
        Toast.LENGTH_SHORT).show();
        }
    }
}
```

Displaying Web Content

Android provides a WebView class that is capable of displaying web content (web pages). The content is specified either using a URI (if it is to be accessed from the network, android.permission.INTERNET permission would be needed) or even from a string. By default the browser controls (address bar, forward button, back button, etc.), JavaScript, zooming, cookies etc., are disabled. But they can be enabled by calling appropriate methods. As a WebView is likely to be large in size, usually it is used as the root element of the layout file, but this is not a requirement.

```
WebView webview = new WebView(this);
setContentView(webview);
// Simplest usage: note that an exception will NOT be thrown
// if there is an error loading this page (see below).
```

```
webview.loadUrl("http://slashdot.org/");
// OR, you can also load from an HTML string:
String summary = "<html><body>You scored <b>192</b> points.
        </body></html>";
webview.loadData(summary, "text/html", null);
// ... although note that there are restrictions on what this
        HTML can do.
```

A WebView has several customization points where you can add your own behavior. These are:

- Creating and setting a WebChromeClient subclass. This class is called when something that might impact a browser UI happens, for instance, progress updates and JavaScript alerts are sent here
- Creating and setting a WebViewClient subclass. It will be called when things happen that impact the rendering of the content, eg, errors or form submissions. You can also intercept URL loading here (via *shouldOverrideUrlLoading()*)
- Modifying the WebSettings, such as enabling JavaScript with *setJavaScriptEnabled()* and injecting Java objects into the WebView using the *addJavascriptInterface(Object, String)* method. This method allows you to inject Java objects into a page's JavaScript context, so that they can be accessed by JavaScript in the page

Capturing Motion Data from Motion Sensors

Mobile devices come with different kinds of motion and position sensors like accelerometer (also known as G-Sensor), gyroscope, compass, etc.

Accelerometers provide data about the acceleration of the device. The change in the position of a thing is called displacement. The rate of change of position (including direction change) is called velocity. It is the derivative of the position with respect to time. The rate of change in velocity is called acceleration. Acceleration is the derivative of velocity with respect to time. Accelerometers measure acceleration in one direction. As we live in a three-dimensional space, three accelerometers are needed to measure the change in position in 3-D. Data returned by accelerometer include the acceleration due to the Earth's gravity. The change in position can be calculated by discounting for gravity and then performing double-integration of acceleration data over time. The results are fairly accurate for short distances, but lose accuracy as the distance increases. In motion-sensor based games, we need to model the movement of various elements accurately as per the laws of physics and data from the

accelerometers. This is commonly called physics in gaming terminology and may be done manually for simple games or using ready-made physics engines for more complicated ones.

Accelerometer data can be used in a variety of applications, including rotation of device display (orientation change from portrait mode to landscape mode and vice versa) when the device is physically rotated, pedometer (step-counting or counting the distance walked), controlling elements in games by device motion, motion-based gestures (like flip the phone to reject a call), etc.

Displaying Accelerometer Data

```
SensorManager sensorManager = (SensorManager)
        getSystemService(Context.SENSOR_SERVICE);
Sensor sensor =
        sensorManager.getDefaultSensor(Sensor.TYPE_ACCELEROMETER);
sensorManager.registerListener(new SensorEventListener() {
        @Override
        public void onSensorChanged(SensorEvent event)
        {
            float x = event.values[0];
            float y = event.values[1];
            float z = event.values[2];
        }

        @Override
        public void onAccuracyChanged(Sensor sensor, int
        accuracy)
        {
        }
    }, sensor, SensorManager.SENSOR_DELAY_FASTEST);
```

Capturing an Image from Camera from within Our App (Using Intent)

Sometimes, we may want to capture an image from within our app. For example, when entering data of a new employee or customer on a mobile device, we may want to capture their photo. Or, while entering data, we may want to capture a photo of some document as a proof. There are some apps that let users sell used things by entering their information the asking price and a photograph. In such cases, we should be able to capture the photograph right from within our app, rather than breaking the flow and asking the user to capture it using a camera app and then selecting the captured image from the gallery.

There are two ways of capturing image from our app. The first, and the simpler, is to invoke an existitng camera app using an intent. The other is to build our own camera app.

To capture image by invoking some camera app using intent, we need to create an intent with the action

```
MediaStore.ACTION_IMAGE_CAPTURE
```

To capture video by invoking some camera app using intent, we need to create an intent with the action

```
MediaStore.ACTION_VIDEO_CAPTURE
```

Code for capturing an image

```
<!-- App can be installed only of the device has camera.
     In manifest file... -->

    <uses-feature android:name="android.hardware.camera"
        android:required="true" />
```

```
// Check for the existance of camera in code
PackageManager packageManager = context.getPackageManager();
if (packageManager.hasSystemFeature(PackageManager.FEATURE_CAMERA)
        == false)
{
    Toast.makeText(getActivity(), "This device does not have a
        camera.",
                                    Toast.LENGTH_SHORT) .show();
    return;
}

// create Intent to take a picture and return control to the
// calling application
Intent intent = new Intent(MediaStore.ACTION_IMAGE_CAPTURE);
// start the image capture Intent
startActivityForResult(intent,CAPTURE_IMAGE_ACTIVITY_REQUEST_CODE);

@Override
protected void onActivityResult(int requestCode, int resultCode,
        Intent data)
{
    if (requestCode == CAPTURE_IMAGE_ACTIVITY_REQUEST_CODE)
    {
```

```
        if (resultCode == RESULT_OK)
        {
            // Image captured
            Bitmap bp = (Bitmap) data.getExtras().get("data");
            imageViewCapturedImage.setImageBitmap(bp);
        }
        else if (resultCode == RESULT_CANCELED)
        {
            // User cancelled the image capture
        } else
        {
            // Image capture failed, advise user
        }
    }
}
```

Scrapbook

View properties:

android:ems android:visibility: Gone, Invisible, Visible

Bundle:

Key-value pairs:

(key1, value1) (key2, value2) (key3, value3) (key4, value4) ... ...

Keys are always of type String. A value may be of any primitive type, of String type, or an array of a primitive type or String.

Activity Stack

```
    USER
     |
     |
     |
     V
Fourth Activity
Third Activity
Second Activity
First Activity
```

Wi-Fi hotspot-based geolocation

SQLite database:

Primary key must be named _id and have a datatype of INTEGER or LONG for adapters like the CursorAdapter (but not otherwise) Any value can be inserted in any data type Internally, date may be stored as text, integer or real Default date format: YYYY-MM-DD Default datetime format: YYYY-MM-DD HH:MM:SS.SSS

Storage Classes and Datatypes

Each value stored in an SQLite database (or manipulated by the database engine) has one of the following storage classes:

```
NULL. The value is a NULL value.

INTEGER. The value is a signed integer, stored in 1, 2, 3, 4, 6,
or 8 bytes depending on the magnitude of the value.

REAL. The value is a floating point value, stored as an 8-byte
IEEE floating point number.

TEXT. The value is a text string, stored using the database
encoding (UTF-8, UTF-16BE or UTF-16LE).

BLOB. The value is a blob of data, stored exactly as it was
input.
```

A storage class is more general than a datatype. The INTEGER storage class, for example, includes 6 different integer datatypes of different lengths. This makes a difference on disk. But as soon as INTEGER values are read off of disk and into memory for processing, they are converted to the most general datatype (8-byte signed integer). And so for the most part, "storage class" is indistinguishable from "datatype" and the two terms can be used interchangeably.

Type Affinity

SQL database engines that use rigid typing will usually try to automatically convert values to the appropriate datatype. Consider this:

```
CREATE TABLE t1(a INT, b VARCHAR(10));
```

```
INSERT INTO t1(a,b) VALUES('123',456);
```

Rigidly-typed database will convert the string '123' into an integer 123 and the integer 456 into a string '456' prior to doing the insert.

In order to maximize compatibility between SQLite and other database engines, and so that the example above will work on SQLite as it does on other SQL database engines, SQLite supports the concept of "type affinity" on columns. The type affinity of a column is the recommended type for data stored in that column. The important idea here is that the type is recommended, not required. Any column can still store any type of data. It is just that some columns, given the choice, will prefer to use one storage class over another. The preferred storage class for a column is called its "affinity".

Each column in an SQLite 3 database is assigned one of the following type affinities:

```
TEXT
NUMERIC
INTEGER
REAL
BLOB
```

(Historical note: The "BLOB" type affinity used to be called "NONE". But that term was easy to confuse with "no affinity" and so it was renamed.)

A column with TEXT affinity stores all data using storage classes NULL, TEXT or BLOB. If numerical data is inserted into a column with TEXT affinity it is converted into text form before being stored.

A column with NUMERIC affinity may contain values using all five storage classes. When text data is inserted into a NUMERIC column, the storage class of the text is converted to INTEGER or REAL (in order of preference) if such conversion is lossless and reversible. For conversions between TEXT and REAL storage classes, SQLite considers the conversion to be lossless and reversible if the first 15 significant decimal digits of the number are preserved. If the lossless conversion of TEXT to INTEGER or REAL is not possible then the value is stored using the TEXT storage class. No attempt is made to convert NULL or BLOB values.

A string might look like a floating-point literal with a decimal point and/or exponent notation but as long as the value can be expressed as an integer, the

NUMERIC affinity will convert it into an integer. Hence, the string '3.0e+5' is stored in a column with NUMERIC affinity as the integer 300000, not as the floating point value 300000.0.

A column that uses INTEGER affinity behaves the same as a column with NUMERIC affinity. The difference between INTEGER and NUMERIC affinity is only evident in a CAST expression.

A column with REAL affinity behaves like a column with NUMERIC affinity except that it forces integer values into floating point representation. (As an internal optimization, small floating point values with no fractional component and stored in columns with REAL affinity are written to disk as integers in order to take up less space and are automatically converted back into floating point as the value is read out. This optimization is completely invisible at the SQL level and can only be detected by examining the raw bits of the database file.)

A column with affinity BLOB does not prefer one storage class over another and no attempt is made to coerce data from one storage class into another.

PendingIntent

Data Model -> Adapter -> AdapterView (ListView / Spinner / GridView / StackView)

Location Access methods:

GPS A-GPS Wi-Fi Hotspot based IP Address based

Adapter

Adapter:

```
View   <-->   Adapter  <-->  Model
```

ContentProvider:

```
Code  <-->   ContentProvider  <-->  Model
```

ListView + Adapter + contentProvider:

```
ListView  <-->  Adapter  <-->  ContentProvider  <-->  Model
```

Any Views (including ListView) + Code + contentProvider:

```
View  <-->  Code  <-->  ContentProvider  <-->  Model
```

Determine if you have an internet connection

ConnectivityManager cm = (ConnectivityManager)context.getSystemService(Context.CONNECTIVITY_SERVICE);

NetworkInfo activeNetwork = cm.getActiveNetworkInfo(); boolean isConnected = activeNetwork != null && activeNetwork.isConnectedOrConnecting();

Determine the type of your internet connection

Device connectivity can be provided by mobile data, WiMAX, Wi-Fi, and ethernet connections.

boolean isWiFi = activeNetwork.getType() == ConnectivityManager.TYPE_WIFI;

Mipmaps:

In computer graphics, mipmaps (also MIP maps) or pyramids [1][2][3] are pre-calculated, optimized sequences of images, each of which is a progressively lower resolution representation of the same image. The height and width of each image, or level, in the mipmap is a power of two smaller than the previous level. Mipmaps do not have to be square. They are intended to increase rendering speed and reduce aliasing artifacts. A high-resolution mipmap image is used for high-density samples, such as for objects close to the camera. Lower-resolution images are used as the object appears farther away. This is a more efficient way of downfiltering (minifying) a texture than sampling all texels in the original texture that would contribute to a screen pixel; it is faster to take a constant number of samples from the appropriately downfiltered textures. Mipmaps are widely used in 3D computer games, flight simulators, other 3D imaging systems for texture filtering and 2D as well as 3D GIS software. Their use is known as mipmapping. The letters "MIP" in the name are an acronym of the Latin phrase multum in parvo, meaning "much in little".[4] Since mipmaps, by definition, are pre-allocated, additional storage space is required to take advantage of them.

Designing Adaptiv Icons:

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=16&cad=rja&uact=8&ved=0ahUKEwjSufG2qK3cAhWGpY8KHbg2DxUQFgiHATAP&url=https%3A%2F%2Fmedium.com%2Fgoogle-design%2Fdesigning-adaptive-icons-515af294c783&usg=AOvVaw2T2-9-HPeqId7vhZLYLUfm

---

Loaders

Loaders have been deprecated as of Android P (API 28). The recommended option for dealing with loading data while handling the Activity and Fragment lifecycles is to use a combination of ViewModels and LiveData. ViewModels survive configuration changes like Loaders but with less boilerplate. LiveData provides a lifecycle-aware way of loading data that you can reuse in multiple ViewModels. You can also combine LiveData using MediatorLiveData , and any observable queries, such as those from a Room database, can be used to observe changes to the data. ViewModels and LiveData are also available in situations where you do not have access to the LoaderManager, such as in a Service. Using the two in tandem provides an easy way to access the data your app needs without having to deal with the UI lifecycle. To learn more about LiveData see the LiveData guide and to learn more about ViewModels see the ViewModel guide.

Types of Applications

- Foreground
- Background
- Intermittent
- Widgets

WebView, WebKit / V8