Mobile Security

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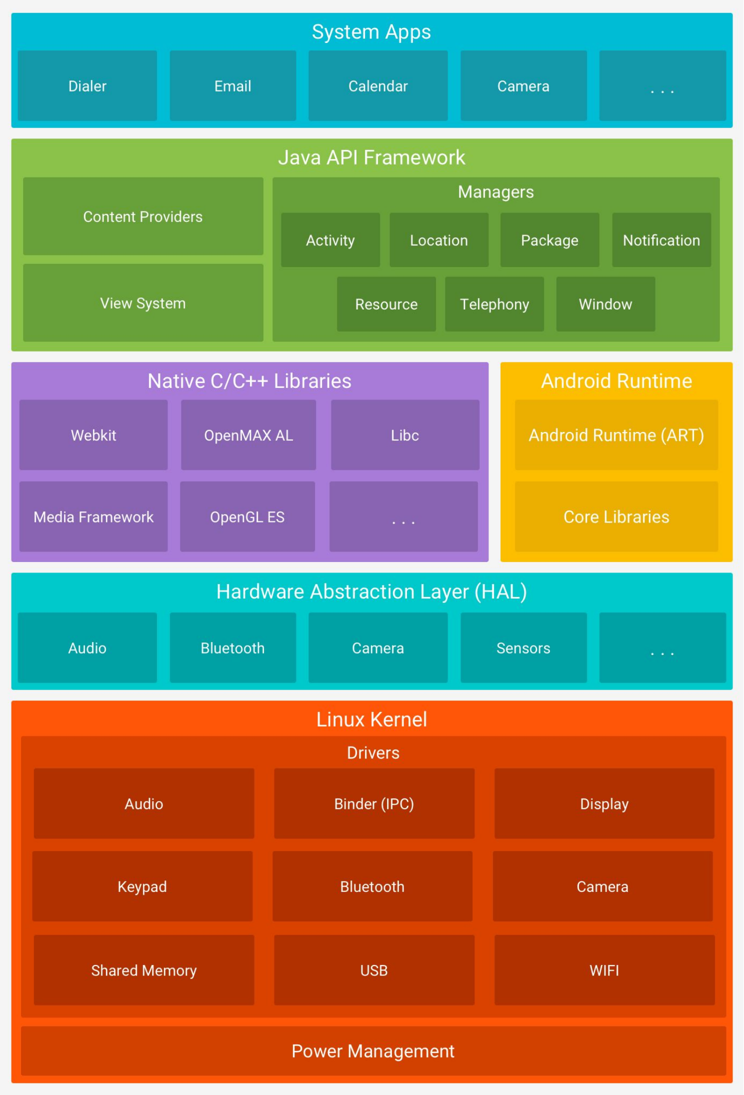
Android Architecture



https://developer.android.com/guide/platform

Android Apps

- User installed apps
- Combination of loosely coupled components
  - Activities
  - Services
  - Broadcast receivers
  - Content providers

==> 4 types of components

- Privilege separation (sandbox)
- Principle of least privilege (permissions)

AndroidManifest File

- Components, permissions and other metadata are specified in the AndroidManifest file
- Package name is an app unique identifier
  - Example: "com.facebook.katana"
- Package name constraints on an Android device and on the Play Store

Basics on Android Apps

- There is no "main"

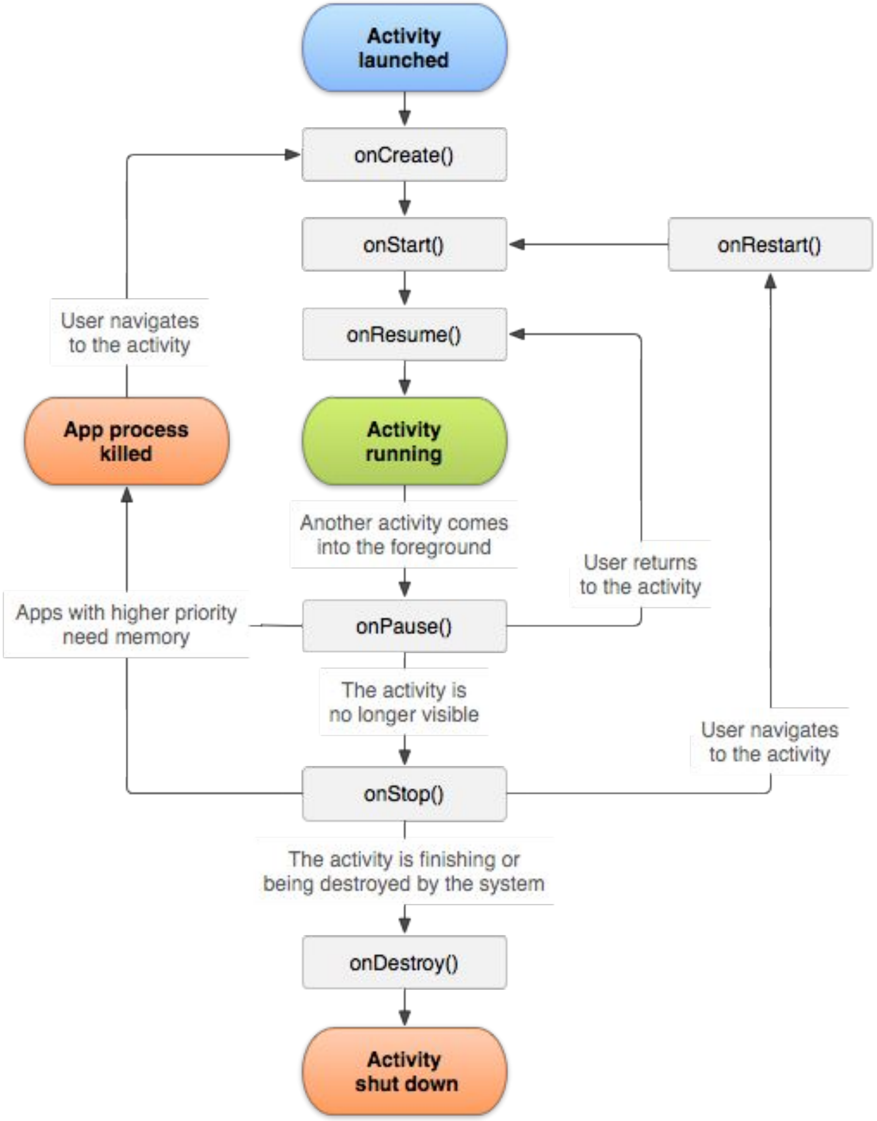
- The user interacts via the Graphical UI
  - Many types of UI Widgets: EditText, Button, ...
  - No command line interface

- Many APIs are "event-driven"
  - 1) You register a "listener" X
  - 2) X's callback is invoked later on

Activity (guide, ref)

- Entry point for interacting with the user. It represents a single screen with a user interface.
- You can have many: each of them defines a UI
- You can define which one is the "main" one
  - This is the chosen one when you start your app
- If the app allows it, an external app can start these activities at will

Activity Life Cycle


Activity launched
onCreate()
onStart()
onRestart()
User navigates to the activity
onResume()
App process killed
Activity running
Another activity comes into the foreground
User returns to the activity
Apps with higher priority need memory
onPause()
The activity is no longer visible
User navigates to the activity
onStop()
The activity is finishing or being destroyed by the system
onDestroy()
Activity shut down

Service

- Performs an action in the background for some period of time, regardless of what the user is doing in foreground (the user could be switching between activities)

- Example: a music player service

- They do not provide a user interface

Broadcast Receiver

- They are meant to respond to system-wide events
- They have a well-defined entry point as well
- The system can deliver these events even to apps that are currently not running
- Example of events: battery charging, sms is received

Content Provider

- They manage a shared set of app data
- High-level API to access data so that other apps and services can query / interact with it
- They abstract away the storing mechanism
- Most often based on SQLite database (file-based)

Communication Between Apps

- IPC mechanisms built on top of the Binder component
  - Intents
    - commands and data delivered to components
  - Messengers
    - objects supporting message-based communication
  - Content providers
    - components exposing cross-process data management interface
  - AIDL
    - enables a client to call a remote object as if it was a local one

Communication Between Apps

- Use cases
  - Notation: "A.X" refers to app A's component X
  - A.X wants to start A.Y (Example: "Go to next activity")
  - A.X wants to send data to B.Z
  - Note: each component has its life cycle! A.Y could already be "started"

Explicit vs. Implicit Intents

- Explicit
  - The intent "explicitly" specifies which component it wants to talk to
  - It specifies the target's full package name / component
- Implicit
  - The intent just describes the type of action to perform (and, optionally, some data)
- Good source of info / tutorial: link

Example of Explicit Intent

```
{
    ...
    Intent i = new Intent(this, SecondActivity.class);
    i.setData("Here is some data for act2");
    i.putExtra("arg1", "And here some more");
    startActivity(i);
    ...
}
```

Example of Implicit Intent

Action

```
{
    ...
    String url = "http://www.google.com";
    Intent i = new Intent(Intent.ACTION_VIEW);
    i.setData(Uri.parse(url));
    startActivity(i);
    ...
}
```

Intent is sent around the system, with the hope that some other apps will do something about it

Intent Filters

- Intent filters are a mechanism for apps to declare something like:
    - "My component X can handle intents of type <TYPE>"

- When an app (a different one, or even itself!) sends an implicit intent, the "system" knows that it can count on X

Android Security Model

- Sandbox model
- Permission model
- App signature
- SELinux
- Verified boot

Android Sandbox Model

- Each app has its UID and dedicated data directory
- Isolation at the process level and at the file level
- The */data/system/packages.list* file contains all the information

```
com.google.android.email                    10037                    0
/data/data/com.google.android.email default 3003,1028,1015
```

Android Permission Model

- Due to the sandbox model, Android apps can access only to their own files and world-readable resources
- Permissions are fine-grained access rights
- Defined in the AndroidManifest file
- Granted in different moments according to their severity level
- Related permissions are mapped into the same GID

App signature

- Apps are signed by their developers
- There is no Certification Authority in Android signatures
- Signatures are used for updating apps
- System apps are signed by a number of platform keys
- Platform keys are generated by the entity responsible for the Android image running

SELinux

- Security Enhanced Linux (SELinux) is a MAC implementation for the Linux kernel
- Android integrates a modified version of SELinux
- SELinux isolates system daemons and apps in different security domains and it defines access policies for each domain
- Enforcing mode is applied to system daemons
- Permissive mode is applied to apps

Verified Boot

- The verification is performed by the kernel through an RSA public key saved into the boot partition
- Device blocks are checked at runtime
- Each device block is hashed and the hash value is compared to the one of the original block
- The kernel itself is verified through a key that is burned into the device