Android Application Model (3)

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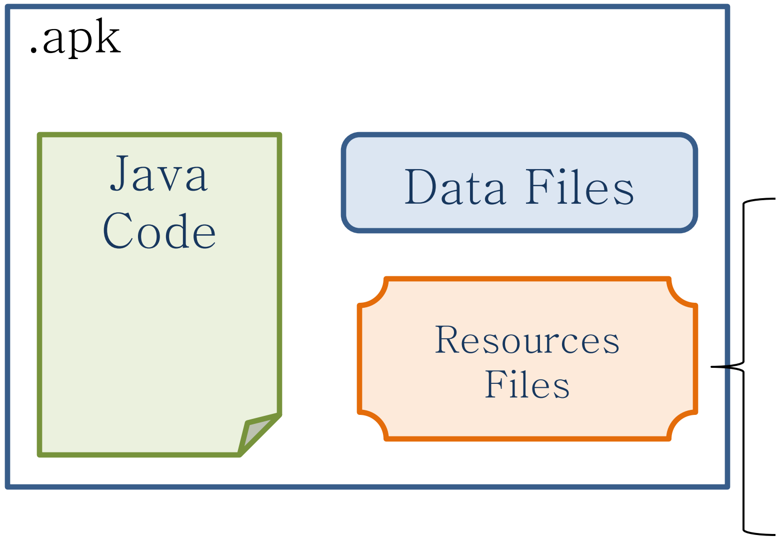
Android Application Package

- Android applications are written in Java.
- An Android application is bundled by the aapt tool into an Android package (.apk)



- res/layout: declaration layout files
- res/drawable: intended for drawing
- res/admin: bitmaps, animations for transitions
- res/values: externalized values
  - ➢**strings**, **colors**, **styles**, etc
- res/xml: general XML files used at runtime
- res/raw: binary files (e.g. sound)

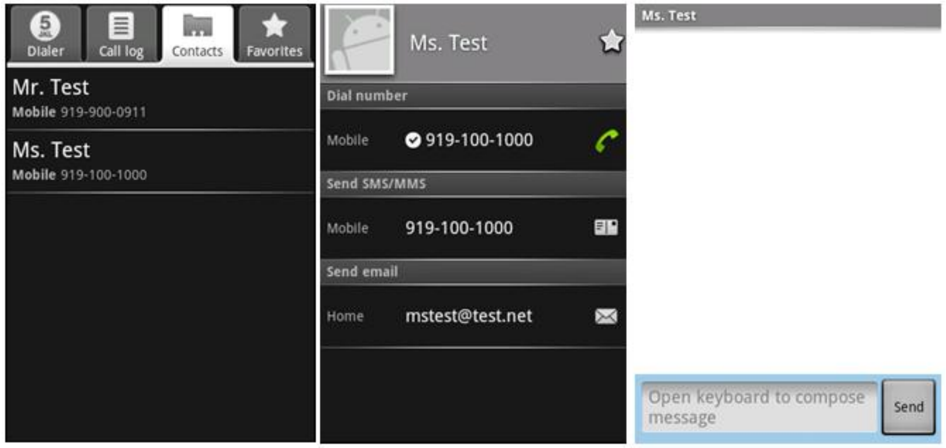
Application Components

- Android applications do not have a single entry point (e.g. no main() function).
- They have essential components that the system can instantiate and run as needed.
- Four basic components

Components	Description
Activity	Componente de UI tipicamente corresponde a un screen
Service	Proceso en background no tiene presentación
Broadcast Receiver	Componente que recibe las notificacione del equipo
Content Provider	Permite compartir información entre aplicaciones

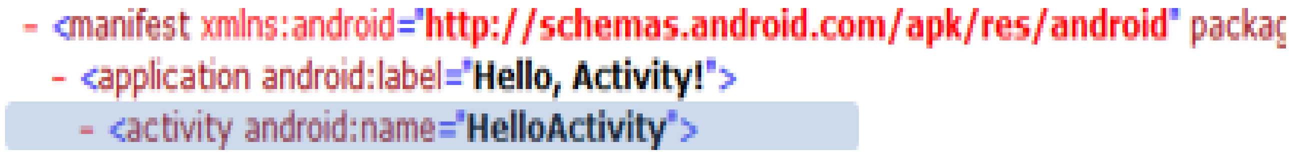
Components - Activity

- An activity is usually a single screen:
  - Implemented as a single class extending Activity.
  - Displays user interface controls (views).
  - Reacts on user input/events.
- An application typically consists of several screens:
  - Each screen is implemented by one activity.
  - Moving to the next screen means starting a new activity.
  - An activity may return a result to the previous activity.



Components - Activity (Cont)

- Typically, one of the activities is marked as the first one that should be presented to the user when the application is launched.
- Created “Activity” must be defined into the application’s manifest.



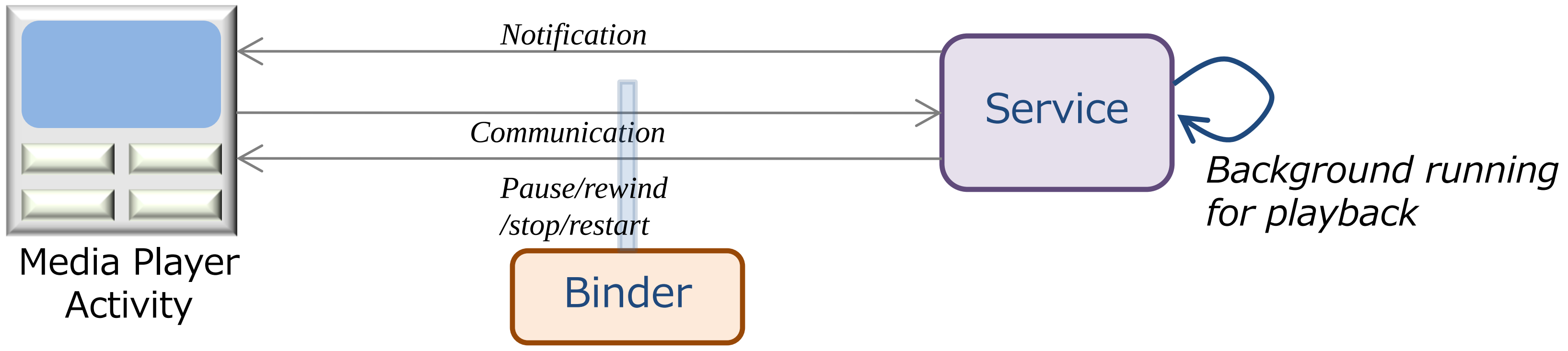
```
- <manifest xmlns:android="http://schemas.android.com/apk/res/android" packag
  - <application android:label="Hello, Activity!">
    - <activity android:name="HelloActivity">
```

Components - Service

- A service does not have a visual user interface, but rather runs in the background for an indefinite period time.

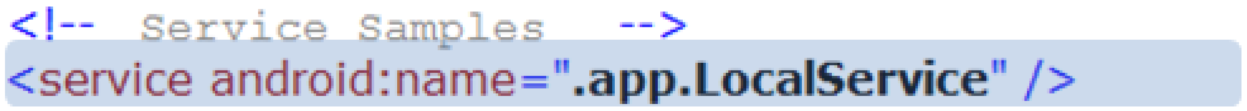
  Example: music player, network download, etc

- Each service extends the Service base class.
- It is possible to bind to a running service and start the service if it's not already running.
- While connected, it is possible communicate with the service through an interface defined in an AIDL (Android Interface Definition Language).



Components - Service (Cont)

- Adding a "Service" with Android is quite similar than for an "Activity".

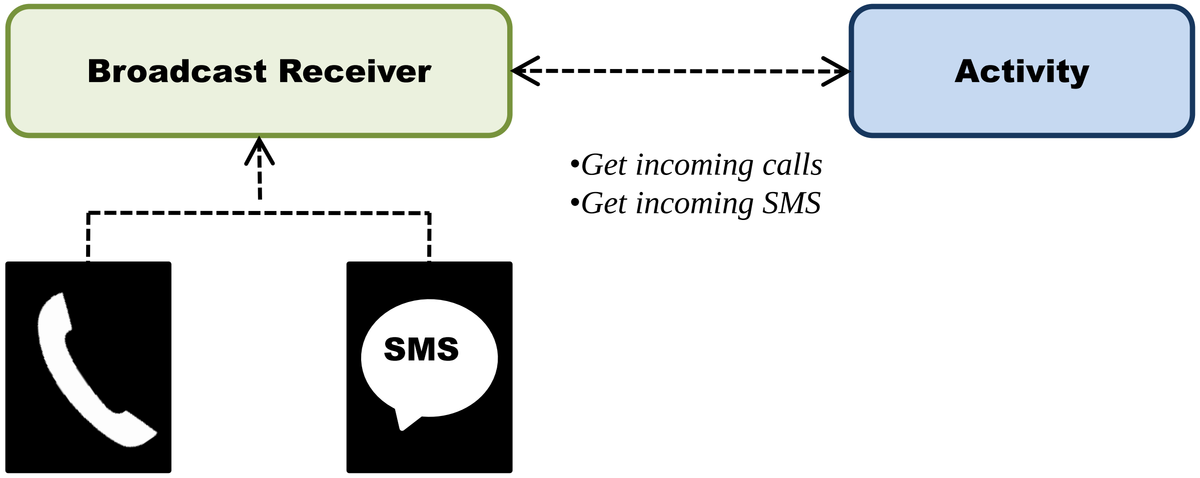


```
<!--  Service Samples   -->
<service android:name=".app.LocalService" />
```

Components - Broadcast Receivers

- A broadcast receiver is a component that receives and reacts to broadcast announcements (Intents).
  - ✓ Many broadcasts originate in system code.

    E.g. announcements that the time zone has changed, that the battery is low, etc.



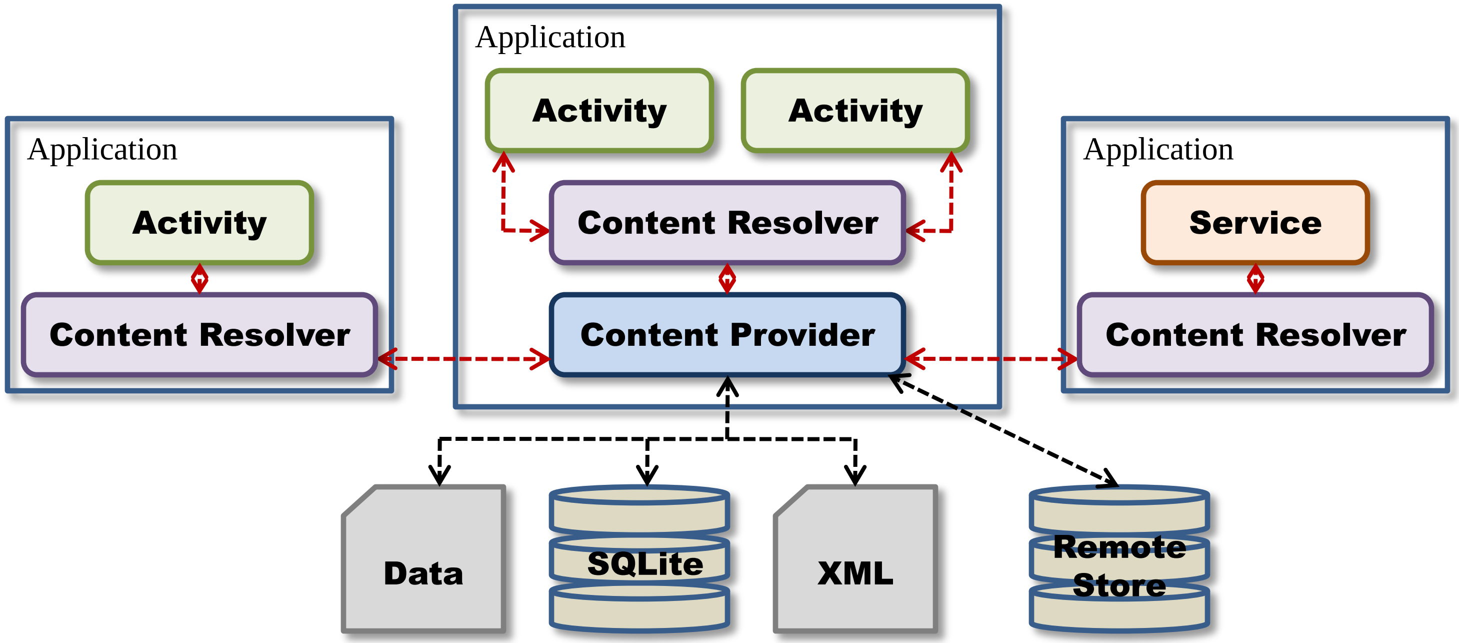
Components - Broadcast Receivers (Cont)

- A broadcast receiver is a component that receives and reacts to broadcast announcements. (Cont)
  - ✓ Applications can also initiate broadcasts.

    E.g. to let other applications know that some data has been downloaded to the device and is available for them to use.

- All receivers extend the ***BroadcastReceiver*** base class.

Components - Content Providers



- A content provider makes a specific set of the application's data available to other applications.
  - ✓ The data can be stored in the file system, in an SQLite, or in any other manner that makes sense.

Components - Content Providers (Cont)

- Using a content provider is the only way to share data between Android applications.
- It extends the ContentProvider bas class and implements a standard set of methods to allow access to a data store.
  - ✓ Querying
  - ✓ Delete, update, and insert data
- Applications do not call these methods directly.
  - ✓ They use a ContentResolver object and call its methods instead.
  - ✓ A ContentResolver can talk to any content provider.
- Content is represented by URI and MIME type.

Intents

- Intents are simple message objects each of which consists of
  - ✓ Action to be performed (MAIN/VIEW/EDIT/PICK/DELETE/DIAL/etc)
  - ✓ Data to operate on (URI)

```
startActivity(new Intent(Intent.VIEW_ACTION, Uri.parse("http://www.fhnw.ch"));

startActivity(new Intent(Intent.VIEW_ACTION, Uri.parse("geo:47.480843,8.211293"));

startActivity(new Intent(Intent.EDIT_ACTION,Uri.parse("content://contacts/people/1"));
```

Intents (Cont)

- Intent Filters
  - ✓ A component's intent filters in the manifest file inform Android of the kinds of intents the component is able to handle.
  - ✓ An example

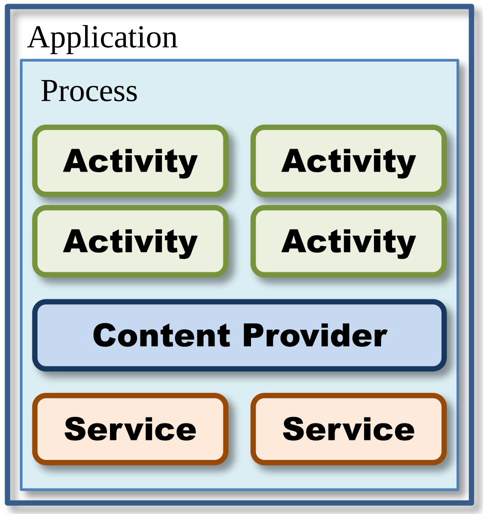
```
<?xml version="1.0" encoding="utf-8"?>
<manifest . . . >
    <application . . . >
        <activity android:name="com.example.project.FreneticActivity"
                  android:icon="@drawable/small_pic.png"
                  android:label="@string/freneticLabel"
                  . . .  >
            <intent-filter . . . >
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
            <intent-filter . . . >
                <action android:name="com.example.project.BOUNCE" />
                <data android:mimeType="image/jpeg" />
                <category android:name="android.intent.category.DEFAULT" />
            </intent-filter>
        </activity>
        . . .
    </application>
</manifest>
```

Intents (Cont)

- Intent Filters (Cont)
  - ✓ An example (Cont)
    - ① A component can have any number of intent filters, each one declaring a different set of capabilities.
    - ② The first filter in the example indicates that the activity is the entry point for the application.
    - ③ The second filter declares an action that the activity can perform on a particular type of data.

Android Component Model

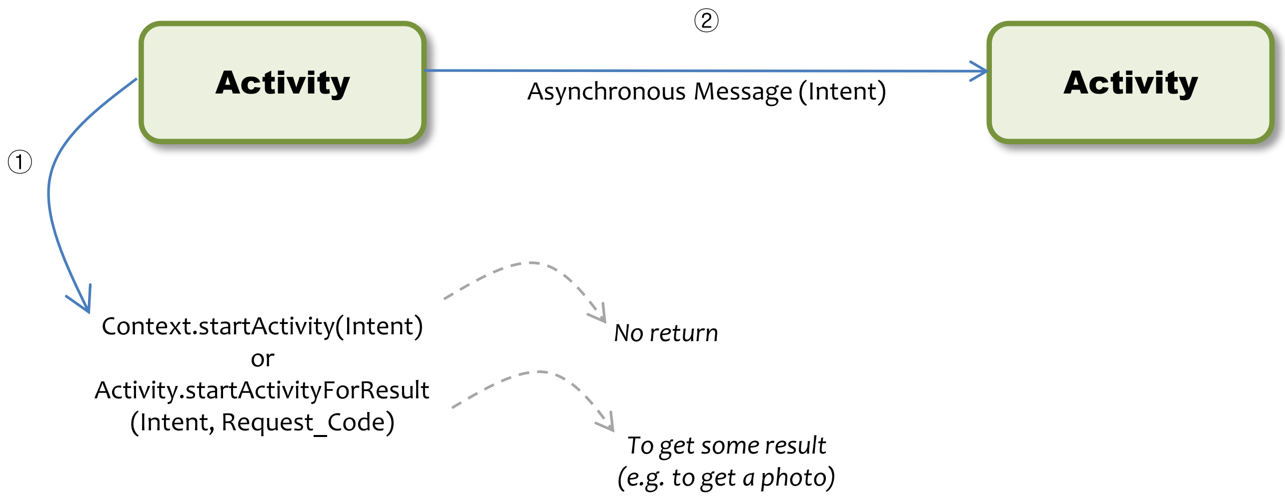
- An Android application is packaged in a .apk file.
  - ✓ A .apk file is a collection of components.



  - ✓ Components share a Linux process: by default, one process per .apk file.
  - ✓ .apk files are isolated and communicate with each other via Intents or AIDL.
  - ✓ Every component has a managed lifecycle.

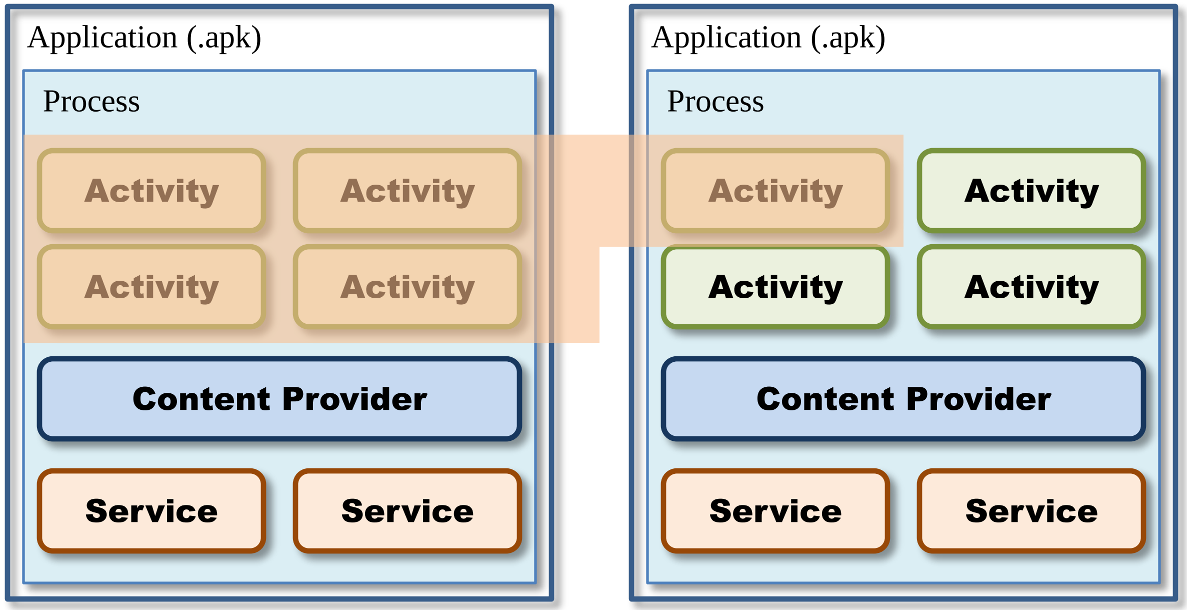
Activities and Tasks

- One activity can start another, including one defined in a different application.



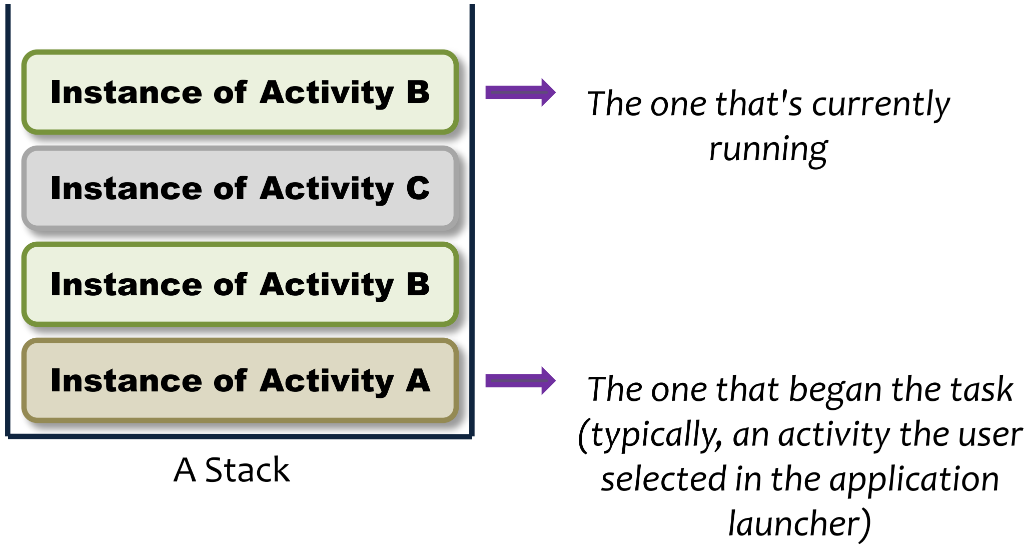
Activities and Tasks (Cont)

- Tasks
  - ✓ A task is a collection of related Activities.
  - ✓ It is capable of spanning multiple processes.



Activities and Tasks (Cont)

- Tasks (Cont)
  - ✓ All activities in a task are arranged in a stack.



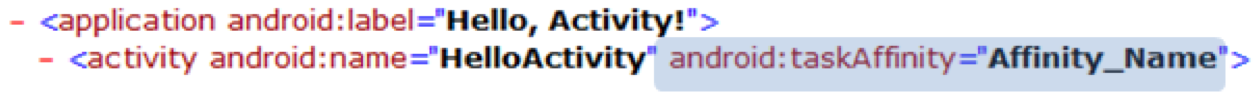
Instance of Activity B
Instance of Activity C
Instance of Activity B
Instance of Activity A
A Stack
The one that's currently running
The one that began the task (typically, an activity the user selected in the application launcher)

① If one activity starts another, the new activity is pushed on the stack and it becomes the running activity.

② When the user presses the BACK key, the current activity is popped from the stack and the previous one resumes.

Activities and Tasks (Cont)

- Affinities
  - ✓ An affinity means a preference for each activity to belong to a certain task.
  - ✓ An individual affinity can be set for each activity:



```
- <application android:label="Hello, Activity!">
  - <activity android:name="HelloActivity" android:taskAffinity="Affinity_Name">
```

  - ✓ By default, a new activity is launched into the task of the activity that called startActivity().

Activities and Tasks (Cont)

- Affinities (Cont)
  - ✓ Two circumstances where the affinity comes into play:

① **FLAG_ACTIVITY_NEW_TASK** flag

If the Intent object passed to startActivity() contains the FLAG_ACTIVITY_NEW_TASK flag, the system looks for a different task to house the new activity.

- If there's already an existing task with the same affinity as the new activity, the activity is launched into that task.
- If not, it begins a new task.

② **allowTaskReparenting** attribute

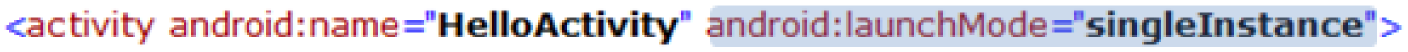
If an activity has its allowTaskReparenting attribute set to "true", it can move from the task it starts in to the task it has an affinity for when that task comes to the fore.

Activities and Tasks (Cont)

- Launch Modes
  - ✓ There are four launch modes:

    standard (default) / singleTop / singleTask / singleInstance

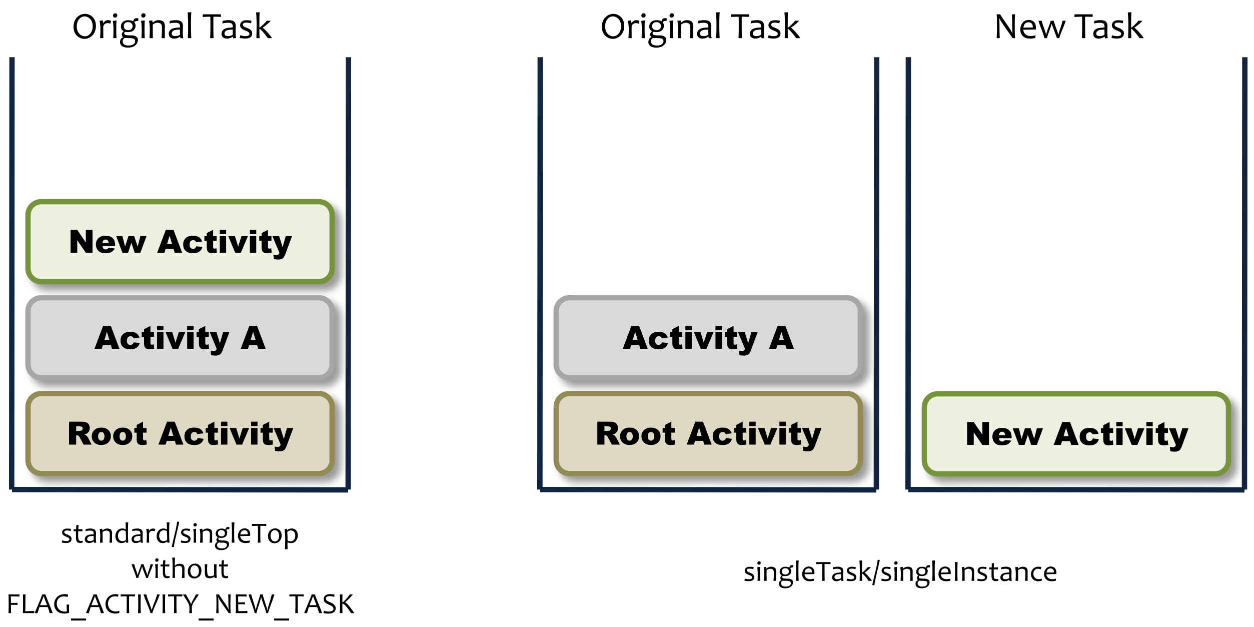
  - ✓ A launch mode can be set for each activity:



```
<activity android:name="HelloActivity" android:launchMode="singleInstance">
```

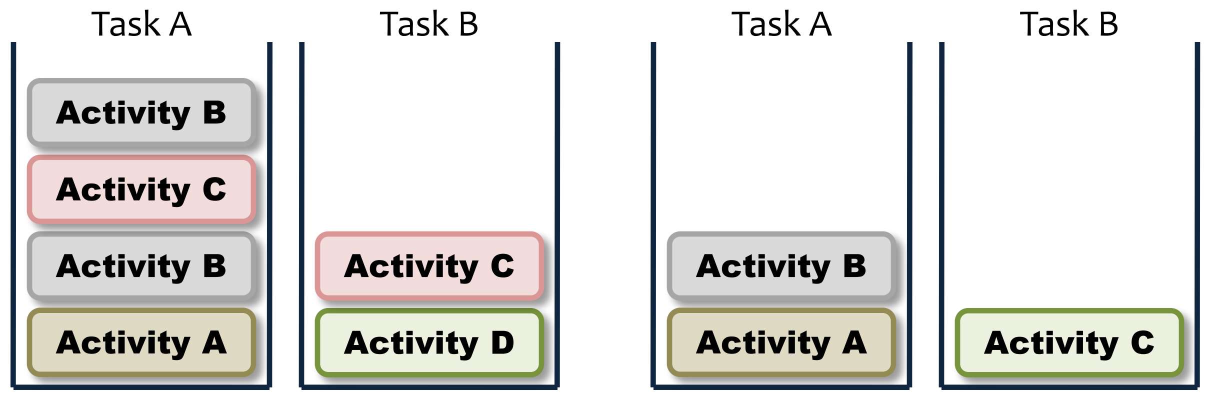
Activities and Tasks (Cont)

- Launch Modes (Cont)
  - ✓ The modes differ from each other on four points:
    - ① *Which task will hold the activity that responds to the intent*



Activities and Tasks (Cont)

- Launch Modes (Cont)
  - ✓ The modes differ from each other on four points: (Cont)
    - ② *Whether there can be multiple instances of the activity*



Activity B and Activity C are standard/singleTop

Activity C is singleTask or singleInstance

- A "standard" or "singleTop" activity can be instantiated many times.
- A "singleTask" or "singleInstance" activity is limited to just one instance.

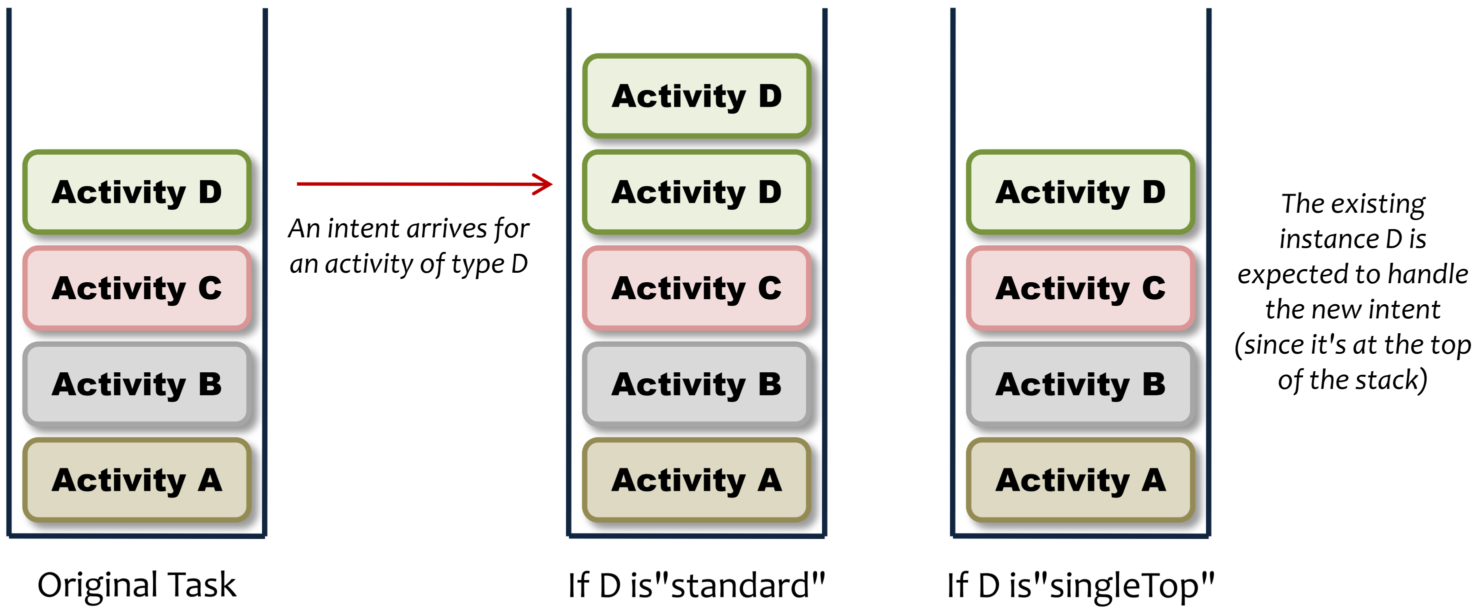
Activities and Tasks (Cont)

- Launch Modes (Cont)
  - ✓ The modes differ from each other on four points: (Cont)
    - ③ *Whether the instance can have other activities in its task*

"standard"	• These modes permit multiple activities to belong to the task. • A "singleTask" activity will always be the root activity of the task.
"singleTop"	
"singleTask"	
"singleInstance"	• An activity stands alone as the only activity in its task.

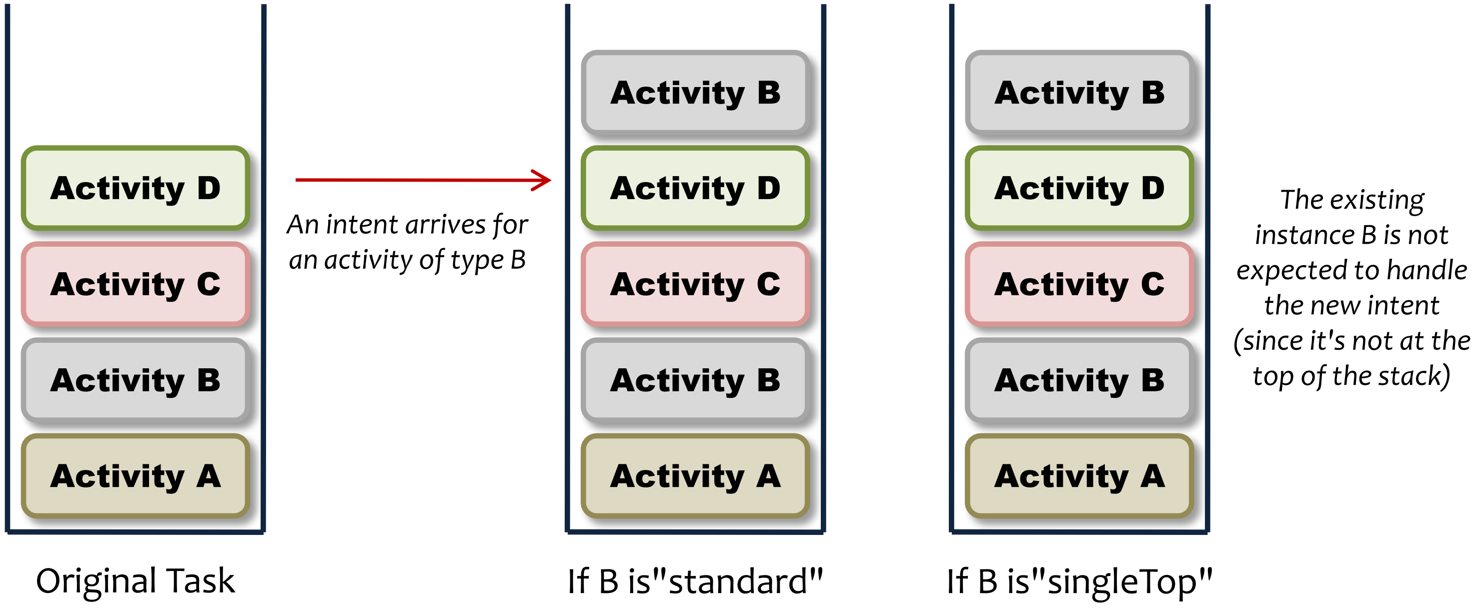
Activities and Tasks (Cont)

- Launch Modes (Cont)
  - ✓ The modes differ from each other on four points: (Cont)
    - ④ *Whether a new instance of the class will be launched to handle a new intent*



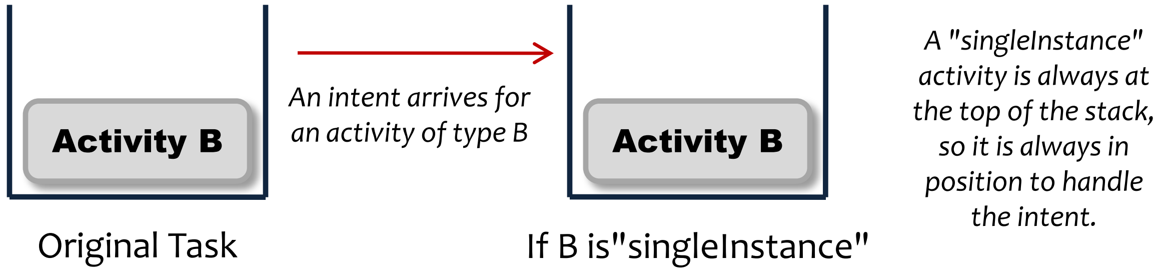
Activities and Tasks (Cont)

- Launch Modes (Cont)
  - ✓ The modes differ from each other on four points: (Cont)
    - ④ *Whether a new instance of the class will be launched to handle a new intent* (Cont)



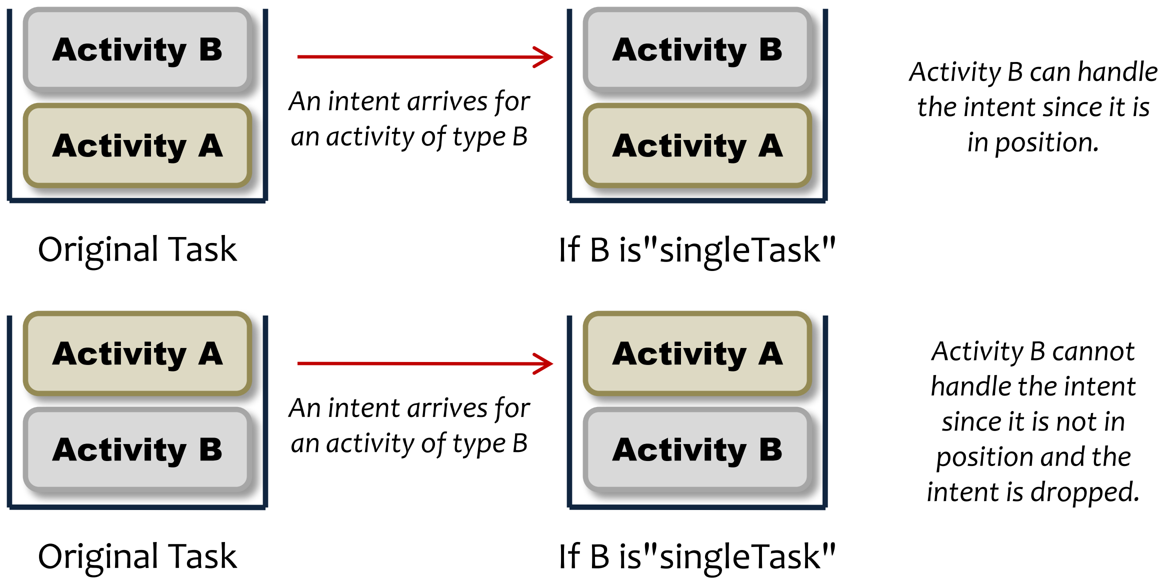
Activities and Tasks (Cont)

- Launch Modes (Cont)
  - ✓ The modes differ from each other on four points: (Cont)
    - ④ *Whether a new instance of the class will be launched to handle a new intent* (Cont)


Activity B
An intent arrives for an activity of type B
Activity B
Original Task
If B is"singleInstance"
A "singleInstance" activity is always at the top of the stack, so it is always in position to handle the intent.

Activities and Tasks (Cont)

- Launch Modes (Cont)
  - ✓ The modes differ from each other on four points: (Cont)
    - ④ *Whether a new instance of the class will be launched to handle a new intent* (Cont)


Activity B
Activity A
An intent arrives for an activity of type B
Activity B
Activity A
Activity B can handle the intent since it is in position.
Original Task
If B is"singleTask"
Activity A
Activity B
An intent arrives for an activity of type B
Activity A
Activity B
Activity B cannot handle the intent since it is not in position and the intent is dropped.
Original Task
If B is"singleTask"

Activities and Tasks (Cont)

- Clearing the Stack
  - ✓ Default Control

    If the user leaves a task for a long time, the system clears the task of all activities except the root activity.
  - ✓ Some activity attributes that can be used to modify the default control:

    ① If alwaysRetainTaskState is set to the root activity of a task
      - The task retains all activities in its stack even after a long period.

    ② If clearTaskOnLaunch is set to the root activity of a task
      - The stack is cleared down to the root activity whenever the user leaves the task and returns to it.
      - The user always returns to the task in its initial state, even after a momentary absence.

Activities and Tasks (Cont)

- Clearing the Stack (Cont)
  - ✓ Some activity attributes that can be used to modify the default control: (Cont)

③ If finishOnTaskLaunch is set to an activity of a task

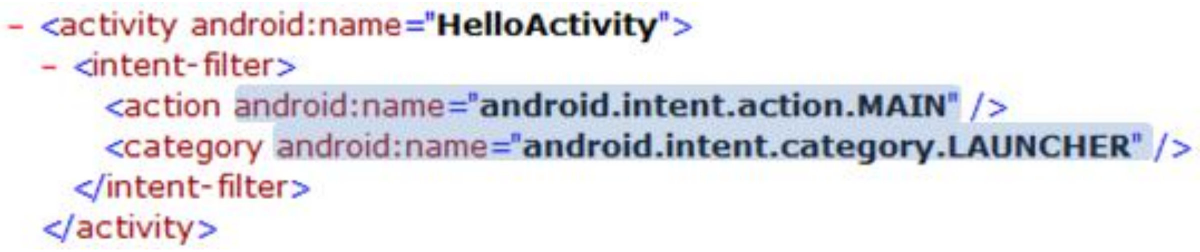
- The activity remains part of the task only for the current session.
- If the user leaves and then returns to the task, it no longer is present.

  - ✓ Another way to force activities to be removed from the stack (FLAG_ACTIVITY_CLEAR_TOP flag):

If an intent includes the FLAG_ACTIVITY_CLEAR_TOP flag and the target task already has an instance of the type of activity that should handle the intent in its stack, all activities above that instance are cleared away.

Activities and Tasks (Cont)

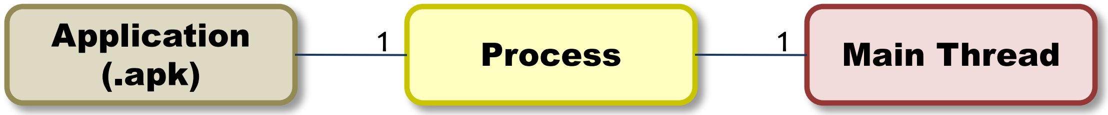
- Starting Tasks
  - ✓ How to set up an activity as the entry point of a task



```
- <activity android:name="HelloActivity">
  - <intent-filter>
      <action android:name="android.intent.action.MAIN" />
      <category android:name="android.intent.category.LAUNCHER" />
    </intent-filter>
  </activity>
```

Processes and Threads

- Processes
  - ✓ When the first of an application's components needs to be run, Android starts a Linux process for it with a single thread of execution (Main Thread).



  - ✓ Android may decide to kill a process to reclaim resources.

Processes and Threads (Cont)

- Process (Cont)
  - ✓ We can specify a process where an individual component should run by setting a process name to “process” attribute of <activity>, <service>, <receiver>, or <provider>.
    - ➢ Each component can run in its own process.
    - ➢ Some components share a process while others do not.
    - ➢ Components of different applications also can run in the same process.
  - ✓ We can set a default value that applies to all components by setting a default process to "process attribute of <application>.

Processes and Threads (Cont)

- Threads
  - ✓ Main Thread
    - All components are instantiated in the main thread of the specified process.
    - System calls to the components are dispatched from the main thread.
      - Methods that respond to those calls always run in the main thread of the process.
      - **No component should perform long or blocking operations** (e.g. network downloads, computation loops)

Processes and Threads (Cont)

- Threads (Cont)
  - ✓ Anything that may not be completed quickly should be assigned to a different thread.
    - ➢ Threads are created in code using standard Java Thread objects.
  - ✓ Some convenience classes Android provides for managing threads:
    - ➢ Looper for running a message loop within a thread
    - ➢ Handler for processing messages
    - ➢ HandlerThread for providing a handy way for starting a new thread that has a looper

Component Lifecycles

- Activity Lifecycle
  - ✓ Three states

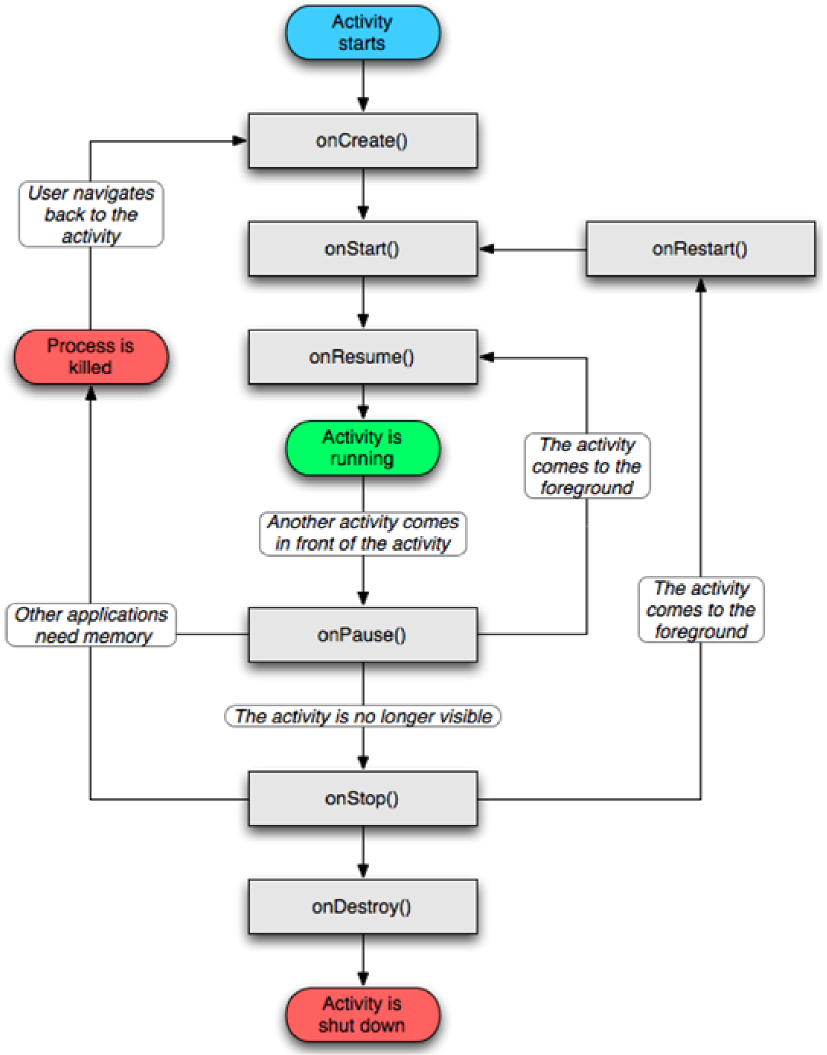
State	Description
Running	• An activity is in the foreground of the screen (at the top of the activity stack for the current task).
Paused	• An activity has lost focus but is still visible to the user.
Stopped	• An activity is completely obscured by another activity. • It still retains all state and member information.

➢ If an activity is paused or stopped, the system can drop it from memory either by:

1. asking it to finish (calling its *finish()* method)
2. simply killing its process.

Component Lifecycles

- Activity Lifecycle (Cont)
  - ✓ An activity's overall lifecycle
    - ➢ onCreate()
      - Called when the activity is first created or when the activity was killed
    - ➢ onStart()
      - Called just before the activity becomes visible to user
    - ➢ onRestart()
      - Called after the activity has been stopped, just prior to it being started again


Activity starts
onCreate()
User navigates back to the activity
onStart()
onRestart()
Process is killed
onResume()
Activity is running
The activity comes to the foreground
Another activity comes in front of the activity
Other applications need memory
onPause()
The activity comes to the foreground
The activity is no longer visible
onStop()
onDestroy()
Activity is shut down

Component Lifecycles (Cont)

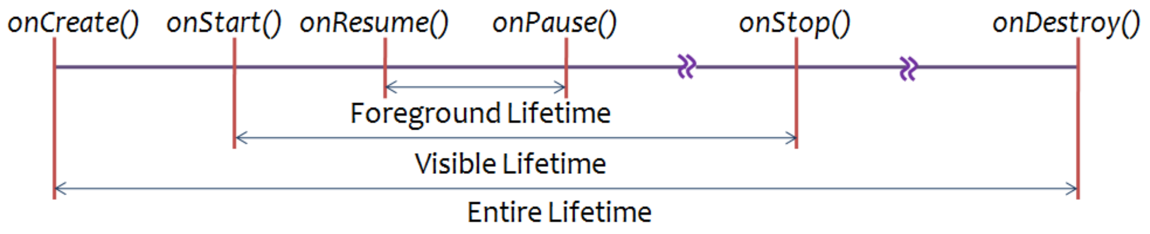
- Activity Lifecycle (Cont)
  - ✓ An activity's overall lifecycle (Cont)
    - onResume()
      - Called just before the activity starts interacting with the user
      - At this point, the activity is at the top of the activity stack, with user input going to it.
    - onPause()
      - Called when the system is about to start resuming 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.

Component Lifecycles (Cont)

- Activity Lifecycle (Cont)
  - ✓ An activity's overall lifecycle (Cont)
    - ➢ onStop()
      - Called when the activity is no longer visible to the user
      - This may happen because it is being destroyed, or because another activity has been resumed and is covering it.
    - ➢ onDestroy()
      - Called before the activity is destroyed

Component Lifecycles (Cont)

- Activity Lifecycle (Cont)
  - ✓ Three nested loops for the entire lifecycle



➢ Visible Lifetime

- During this time, the user can see the activity on-screen, though it may be in the foreground and interacting with the user.
- onStart() and onStop() can be called multiple times, as the activity alternates between being visible and hidden to the user.

➢ Foreground Lifetime

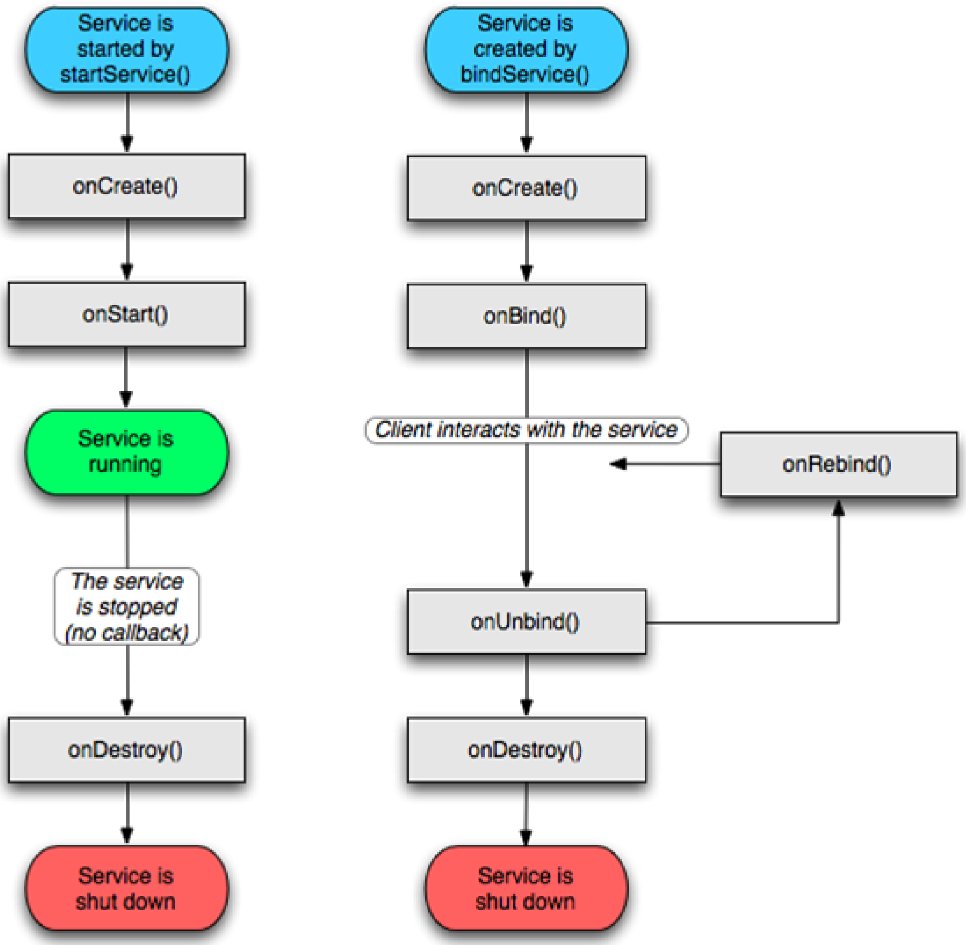
- During this time, the activity is in front of all other activities on screen and is interacting with the user.

Component Lifecycles (Cont)

- Service Lifecycle
  - ✓ Two ways that a service can be used
    - ➢ The service can be started and allowed to run until someone stops it or it stops itself.
      - started by calling Context.startService() and stopped by calling Context.stopService()
    - ➢ The service can be operated programmatically using an interface that it defines and exports.
      - Clients establish a connection to the Service object and use that connection to call into the service.
      - established by calling Context.bindService() and closed by calling Context.unbindService()

Component Lifecycles (Cont)

- Service Lifecycle (Cont)



Service is started by startService()
onCreate()
onStart()
Service is running
The service is stopped (no callback)
onDestroy()
Service is shut down
Service is created by bindService()
onCreate()
onBind()
Client interacts with the service
onRebind()
onUnbind()
onDestroy()
Service is shut down

Component Lifecycles (Cont)

- Broadcast Receiver Lifecycle
  - ✓ Only single callback method

    void onReceive(Context curContext, Intent broadcastMsg)

    - ➢When a broadcast message arrives for the receiver, Android calls the method and passes it the Intent object containing the message.

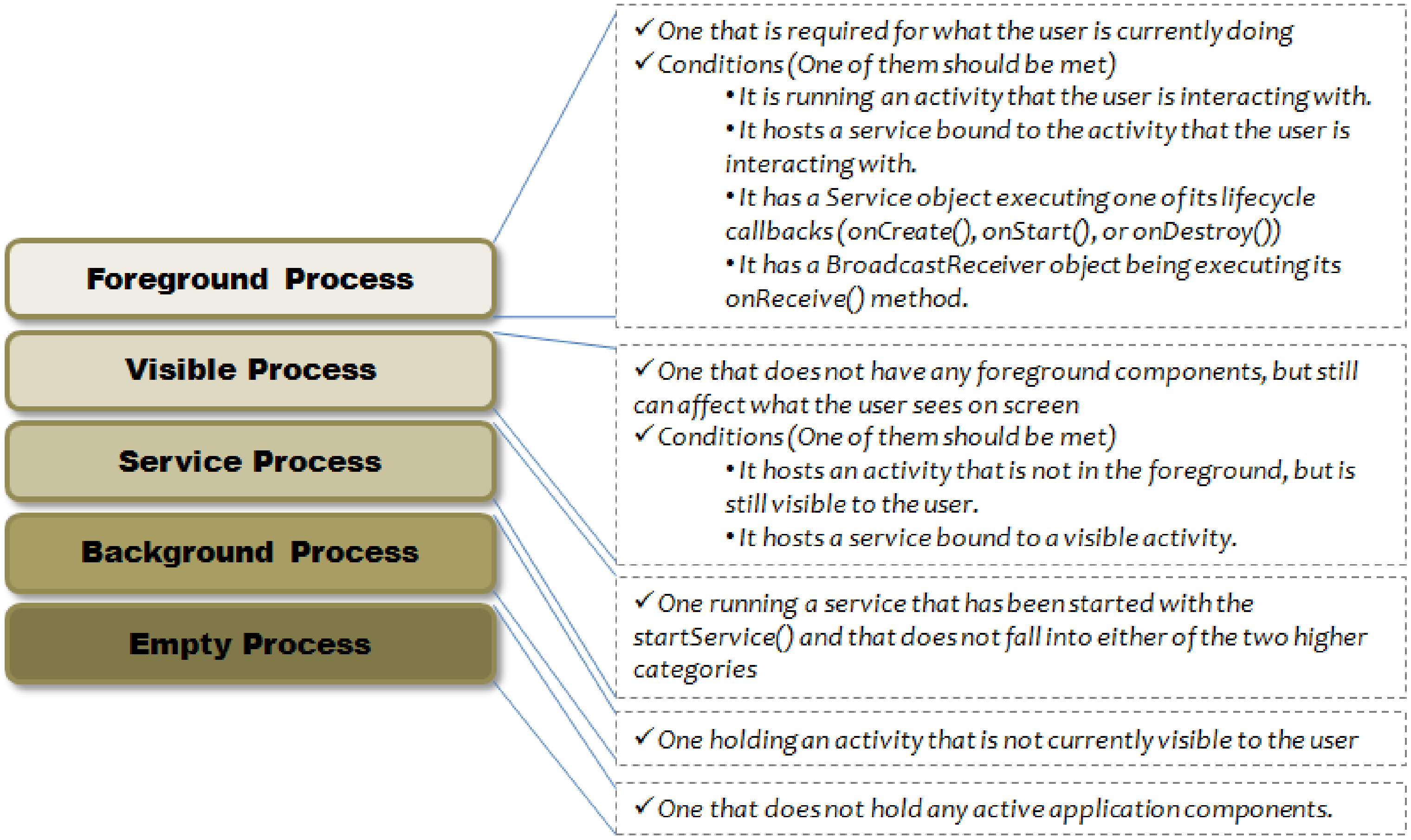
  - ✓ A process with an active broadcast receiver is protected from being killed but a process with only inactive components can be killed by the system at any time.

Component Lifecycles (Cont)

- Processes and Lifecycles
  - ✓ Android tries to maintain a process for as long as possible, but eventually it will need to remove old processes when memory runs low.
    - ➢ To determine candidates to be killed, Android places each process into an "importance hierarchy" based on the components running in it and the state of those components.

Component Lifecycles (Cont)

- Processes and Lifecycles (Cont)
  - ✓ Five levels in the Importance Hierarchy



✓ One that is required for what the user is currently doing
✓ Conditions (One of them should be met)
- It is running an activity that the user is interacting with.
- It hosts a service bound to the activity that the user is interacting with.
- It has a Service object executing one of its lifecycle callbacks (onCreate(), onStart(), or onDestroy())
- It has a BroadcastReceiver object being executing its onReceive() method.

✓ One that does not have any foreground components, but still can affect what the user sees on screen
✓ Conditions (One of them should be met)
- It hosts an activity that is not in the foreground, but is still visible to the user.
- It hosts a service bound to a visible activity.

✓ One running a service that has been started with the startService() and that does not fall into either of the two higher categories

✓ One holding an activity that is not currently visible to the user

✓ One that does not hold any active application components.