Framework Examples: Part 2

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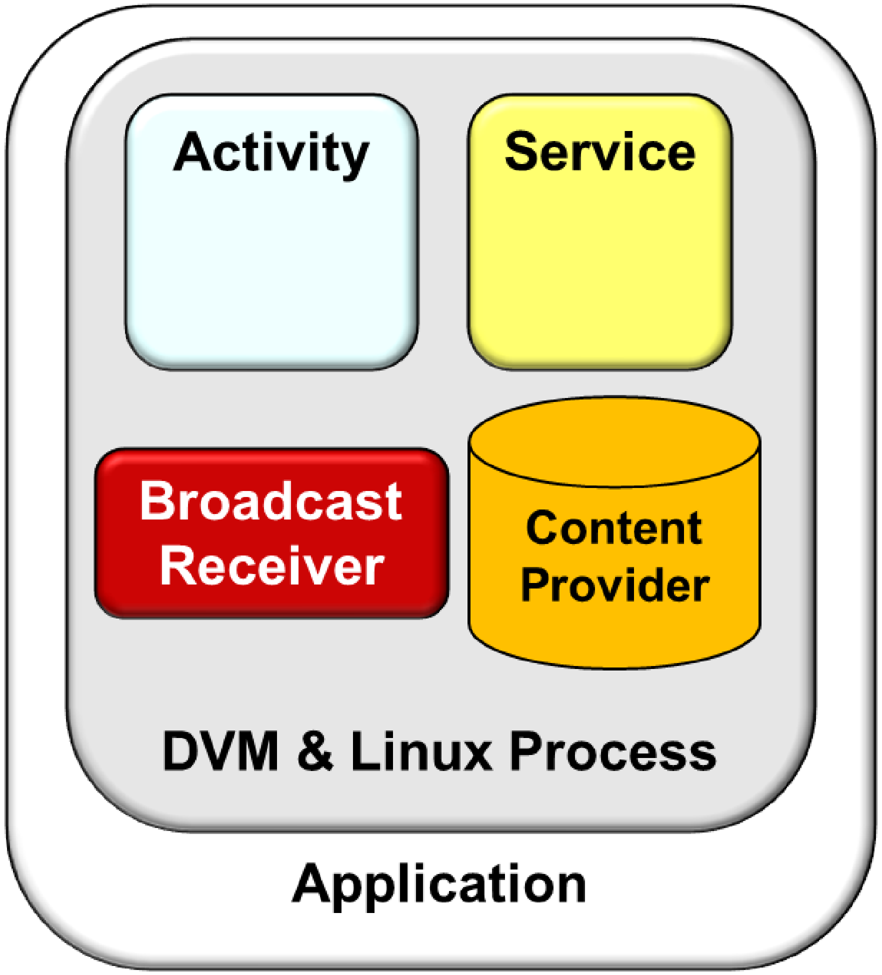
Topics Covered in this Part of the Module

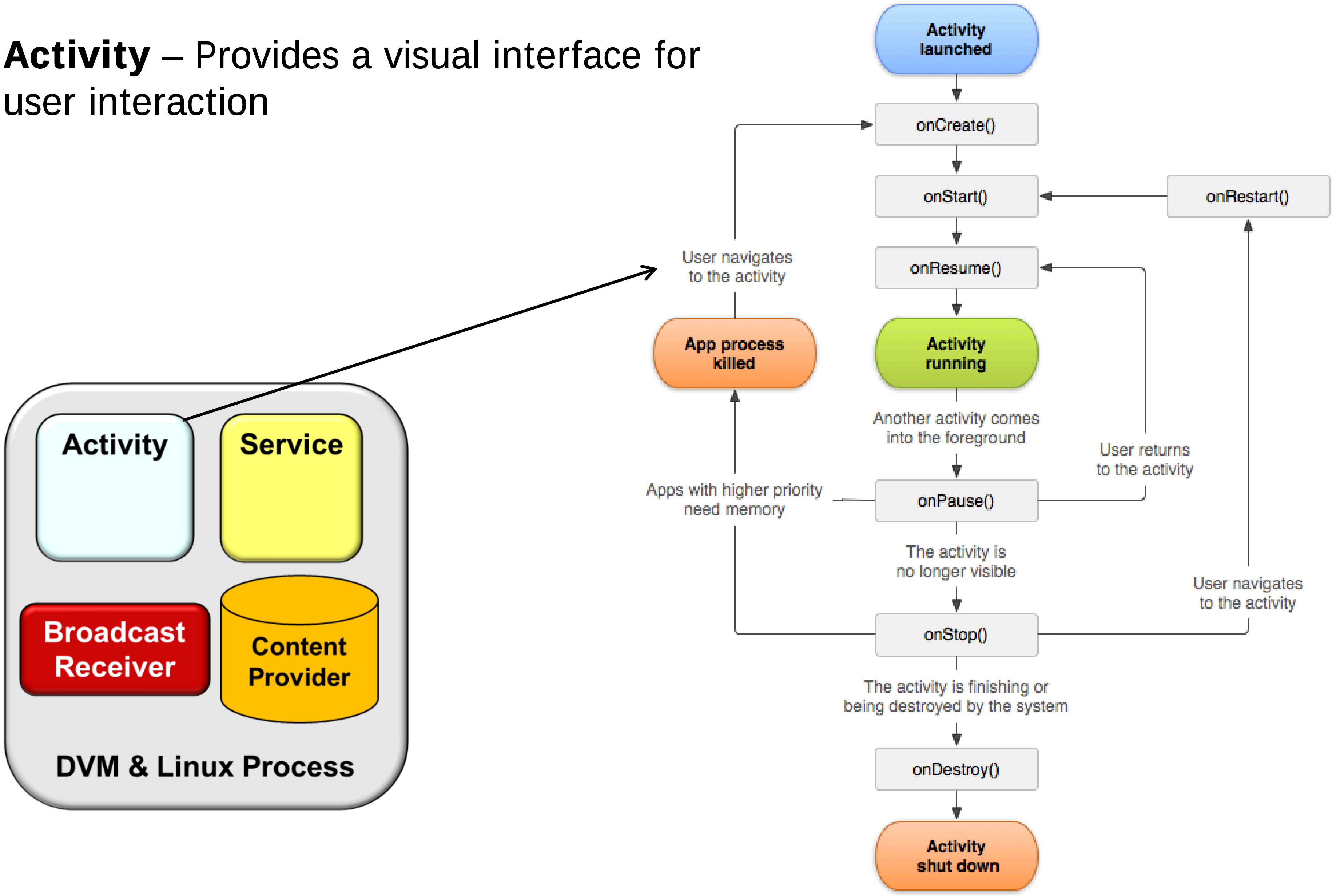
- Present *Scope, Commonality, & Variability* (SCV) analysis as a method for developing & applying software product-lines & frameworks
- Illustrate the application of SCV to the Android & ACE platforms
- Describe examples of Android framework components



We'll emphasize commonalities & variabilities in our discussion

Example Android Framework Components

- **Activity** – Provides a visual interface for user interaction


Activity
Service
Broadcast Receiver
Content Provider
DVM & Linux Process
Activity launched
onCreate()
onStart()
onRestart()
User navigates to the activity
onResume()
App process killed
Activity running
Another activity comes into the foreground
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Apps with higher priority need memory
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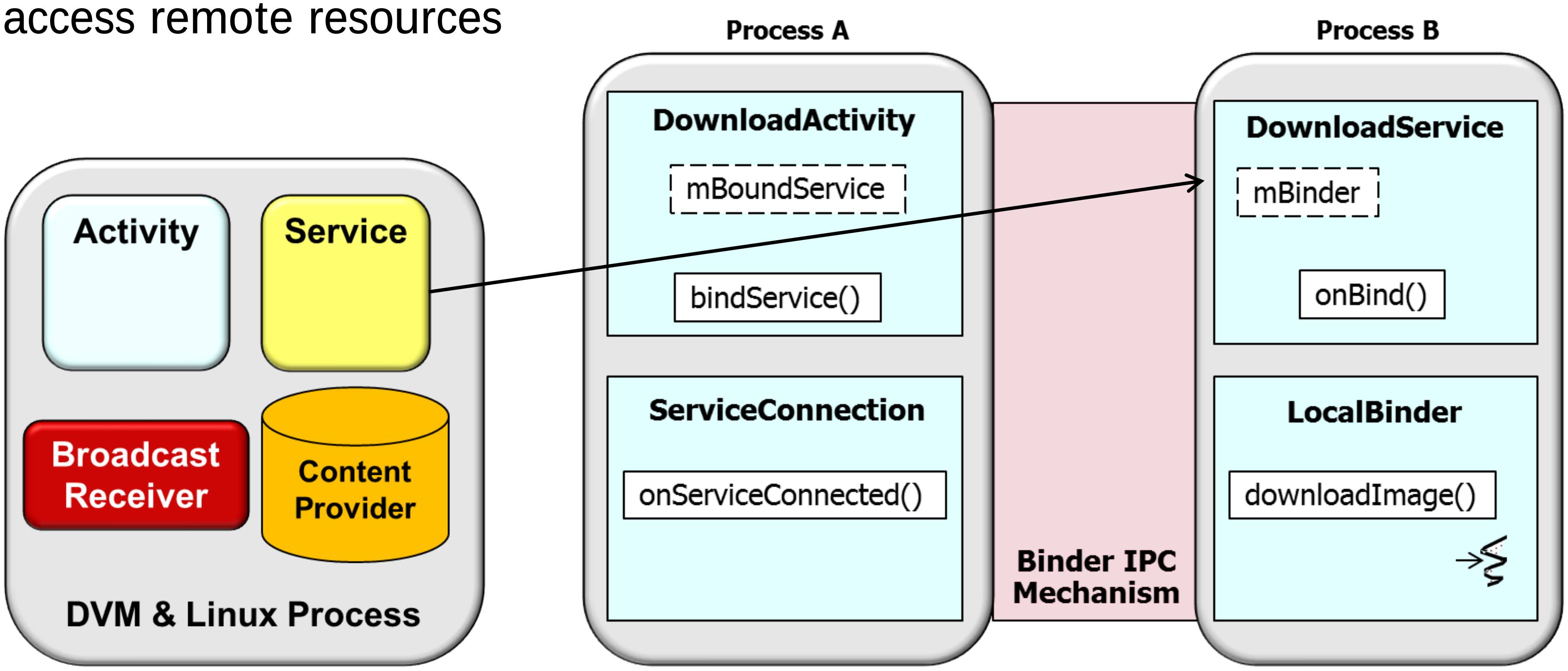
The activity is finishing or being destroyed by the system
onDestroy()
Activity shut down

Example Android Framework Components

- **Activity** – Provides a visual interface for user interaction
- **Service** – Runs in background to perform long-running operations or to access remote resources



Recap of an Android Activity

- An Activity provides a visual interface for user interaction

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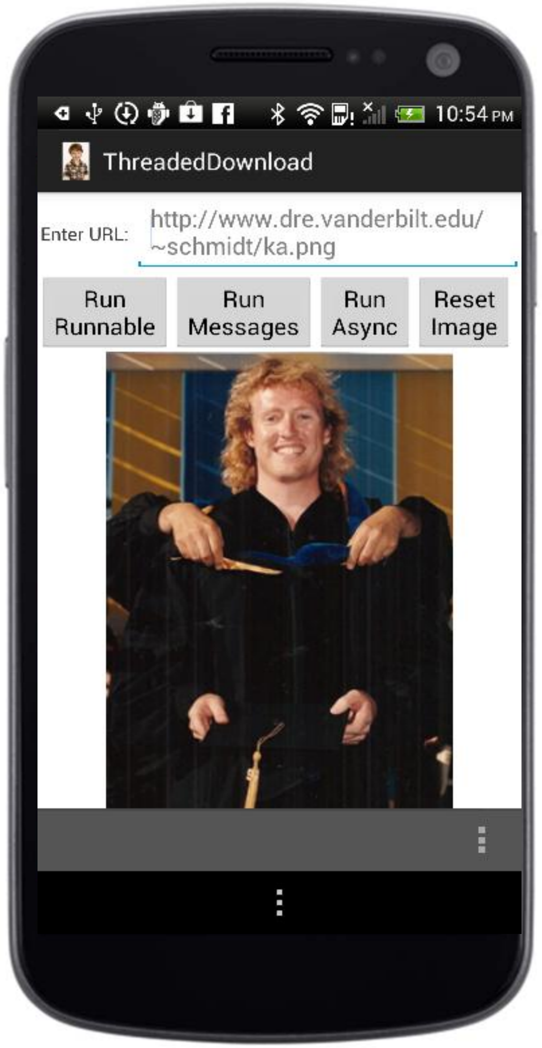
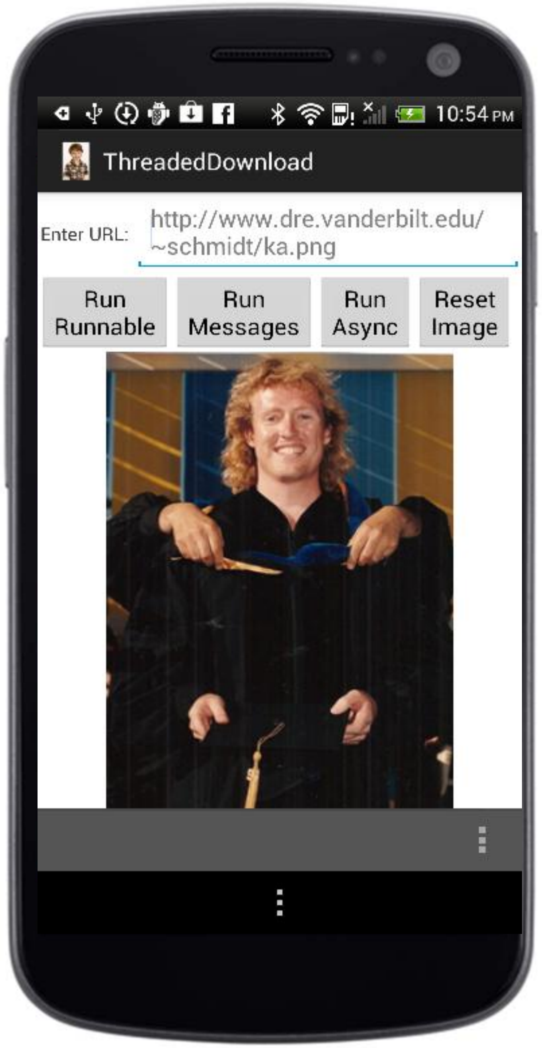
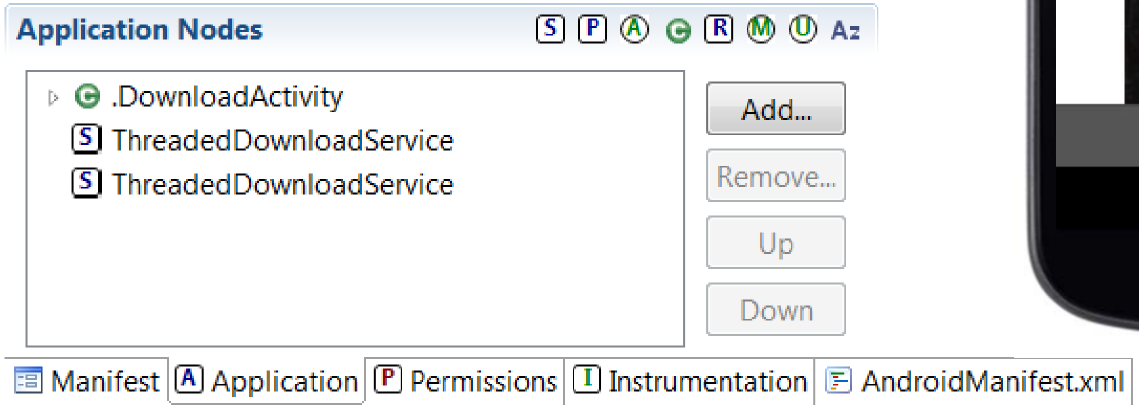
- Typically supports one thing a user can do, e.g.:
  - View an email message
  - Show a login screen
  - Download a file from a remote server



Recap of an Android Activity

- An Activity provides a visual interface for user interaction
- Typically supports one thing a user can do, e.g.:
  - View an email message
  - Show a login screen
  - Download a file from a remote server
- Applications can include one or more activities





.DownloadActivity
ThreadedDownloadService
ThreadedDownloadService

See developer.android.com/training/basics/activity-lifecycle/index.html for more

Implementing an Activity

- Implementing an Activity involves several steps
  - e.g., inherit from Activity class, override lifecycle hook methods, include Activity in the config file AndroidManifest.xml, etc.

```
public class Activity extends
                 ...{
   protected void onCreate
     (Bundle savedInstanceState);
   protected void onStart();
   protected void onRestart();
   protected void onResume();
   protected void onPause();
   protected void onStop();
   protected void onDestroy();
   ...
}
```

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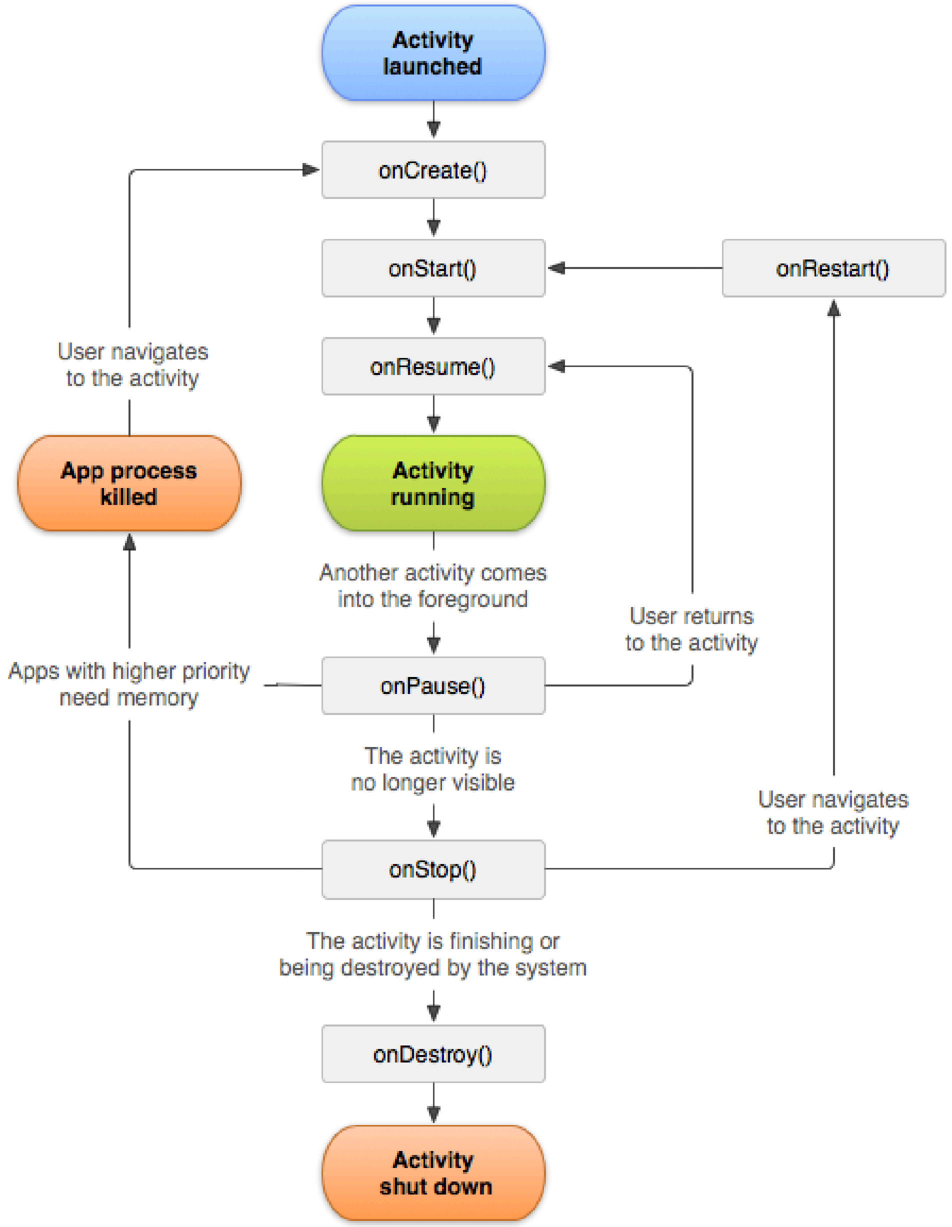
- Android communicates state changes to an Activity by calling its lifecycle hook methods


Activity launched
onCreate()
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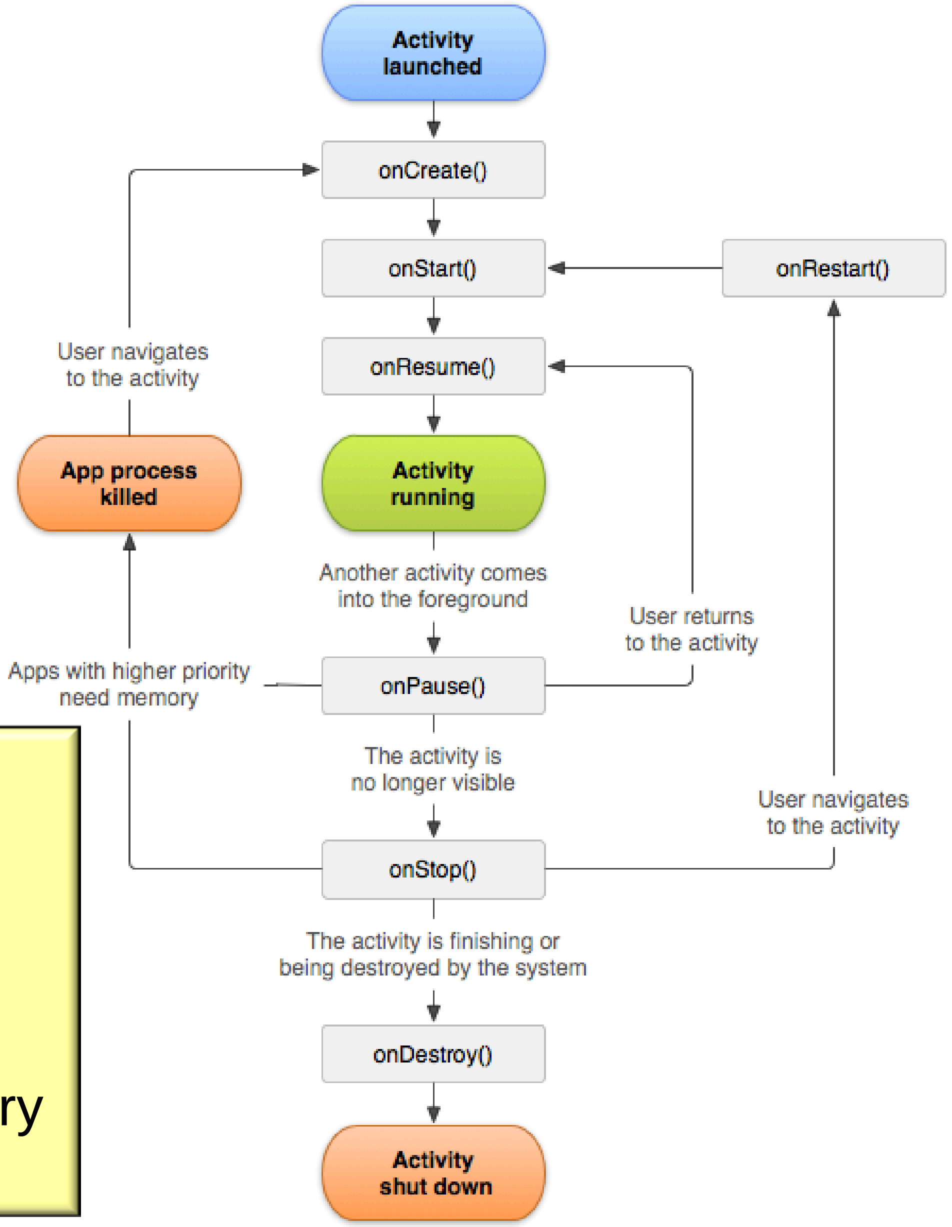
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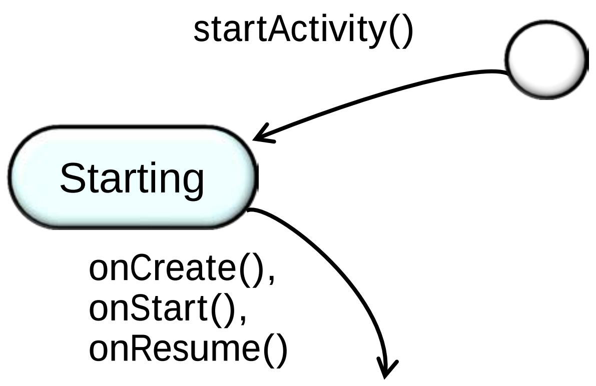
- **Commonality**: Provides common interface for interacting with user, including operations performed when moving between lifecycle states
- **Variability**: Subclasses can override lifecycle hook methods to do necessary work when an Activity changes state

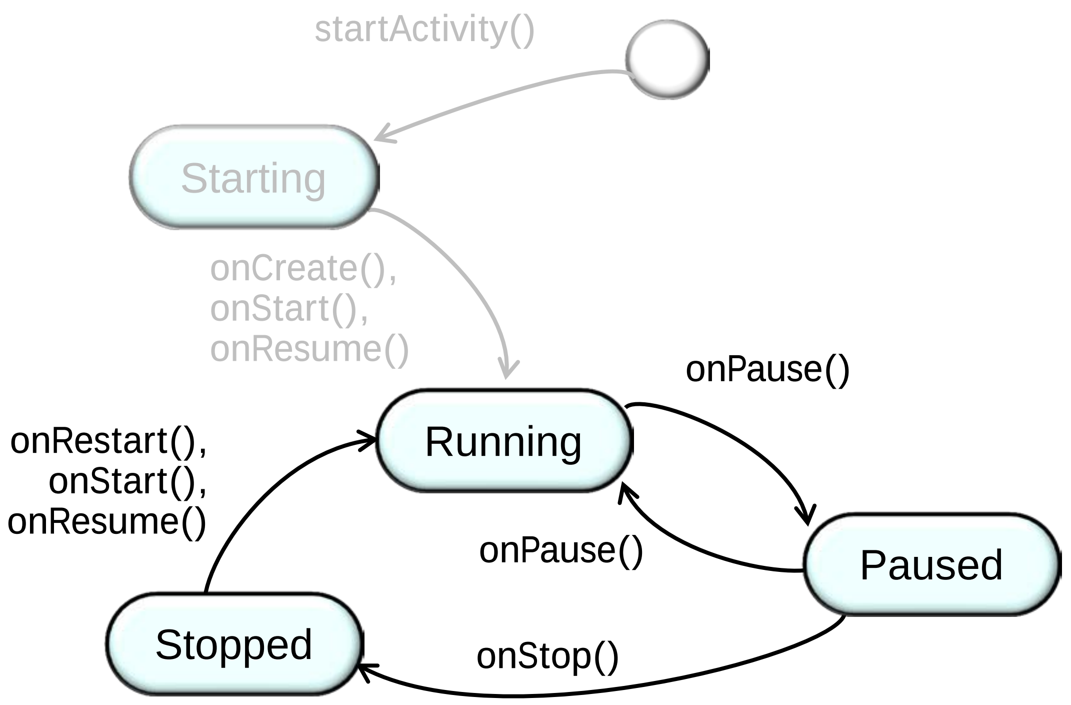
Activity Lifecycle States

- **Activity starting** – Initialization steps



Activity Lifecycle States

- **Activity starting** – Initialization steps
- **Activity running**
  - *Running* – visible, has focus
  - *Paused* – visible, does not have focus, can be terminated
  - *Stopped* – not visible, does not have focus, can be terminated



Activity Lifecycle States

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- **Activity running**
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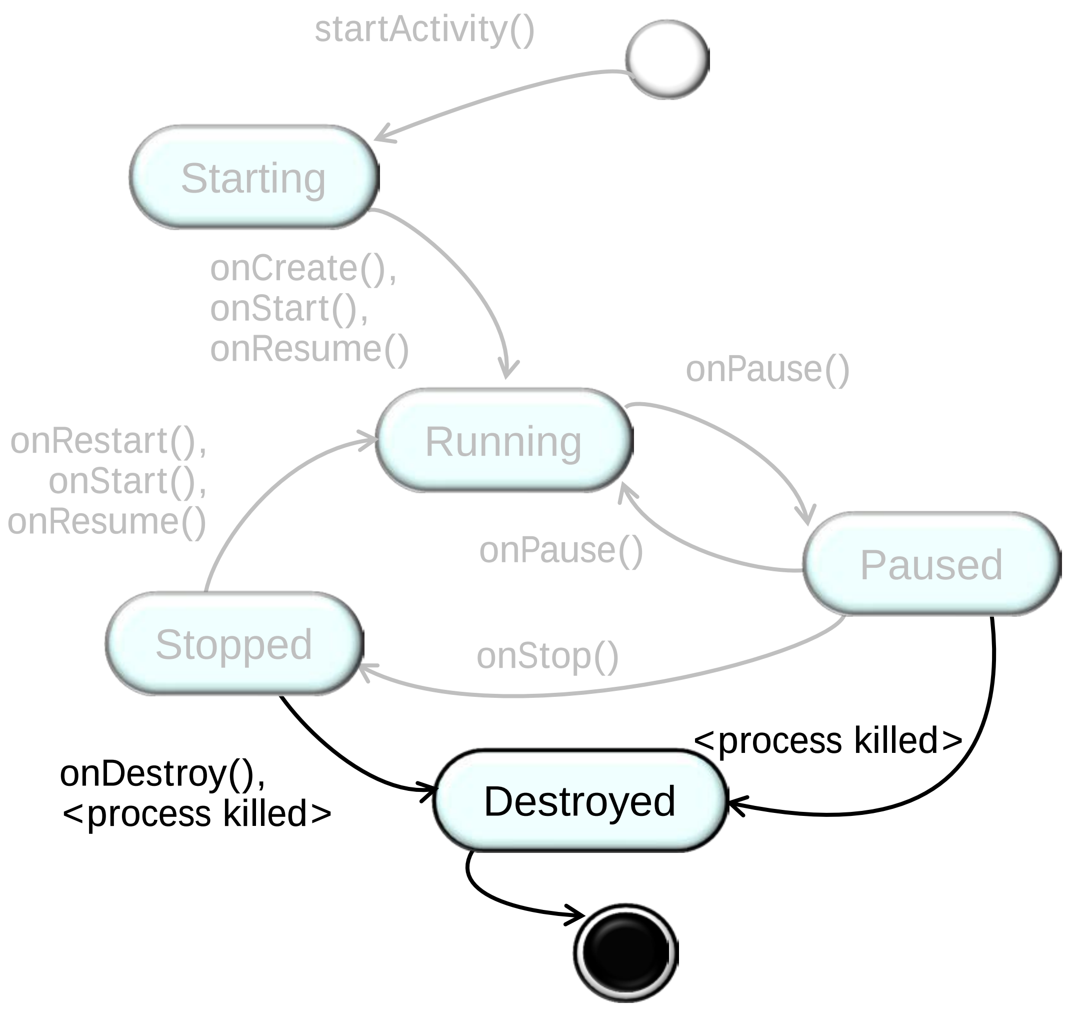
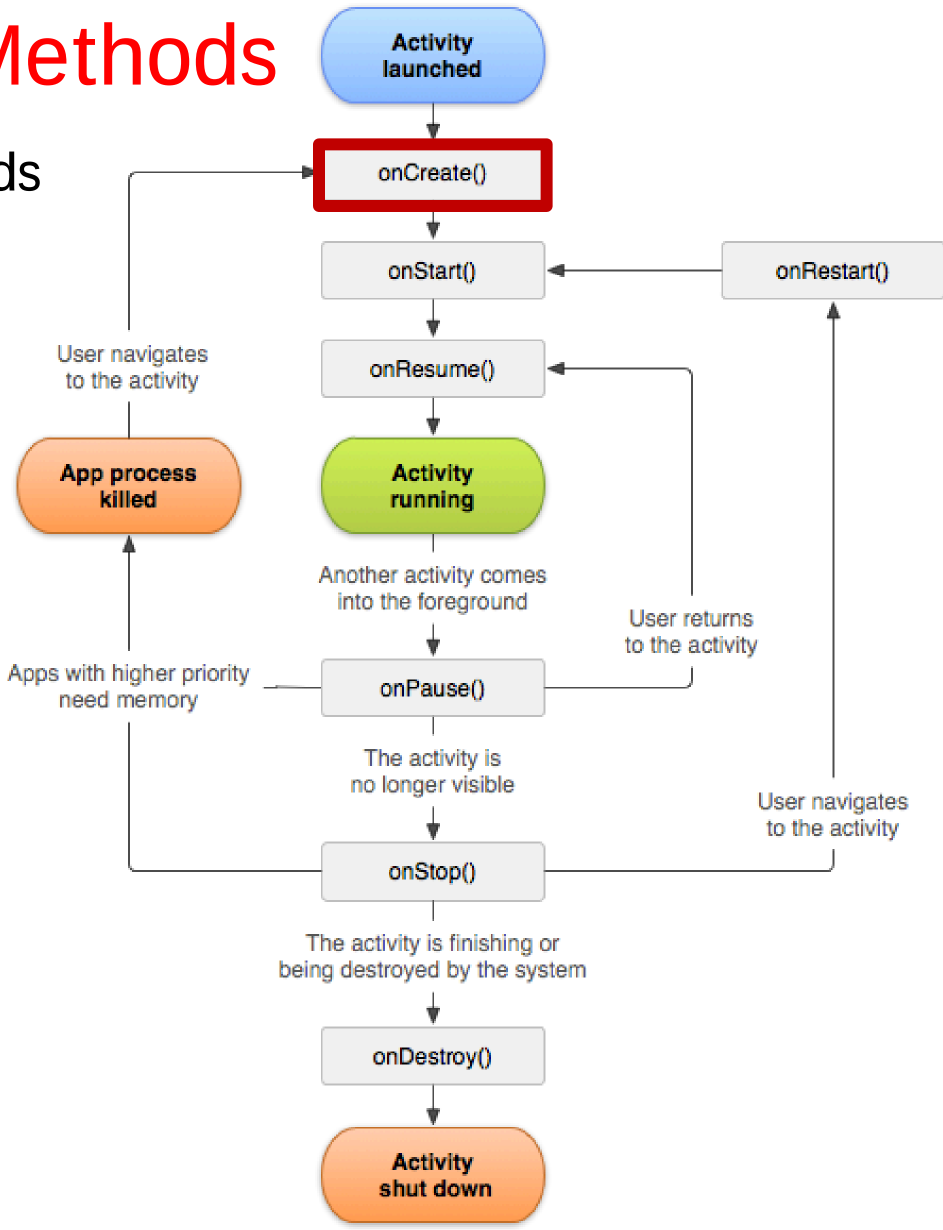
  - *Stopped* – not visible, does not have focus, can be terminated
- **Activity shut down** – Voluntarily finished or involuntarily killed by the system


startActivity()
Starting
onCreate(), onStart(), onResume()
Running
onPause()
Paused
onRestart(), onStart(), onResume()
onPause()
Stopped
onStop()
<process killed>
onDestroy(), <process killed>
Destroyed

See developer.android.com/guide/components/activities.html for more info

Activity Lifecycle Hook Methods

- The Android runtime calls hook methods on an Activity to control its lifecycle:
  - **onCreate()** – called to initialize an Activity when it is first created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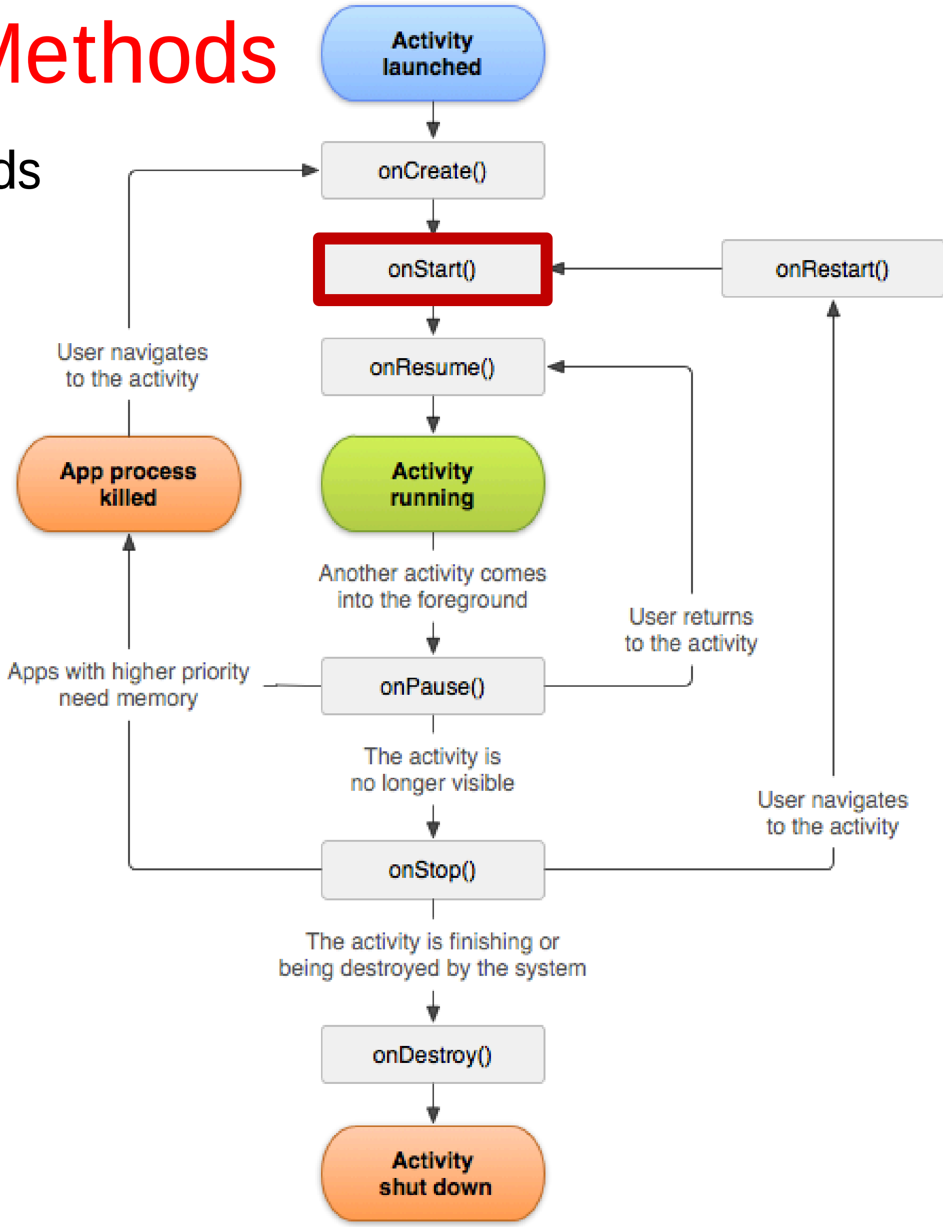
  - **onStart()** – called when Activity is becoming visible to the user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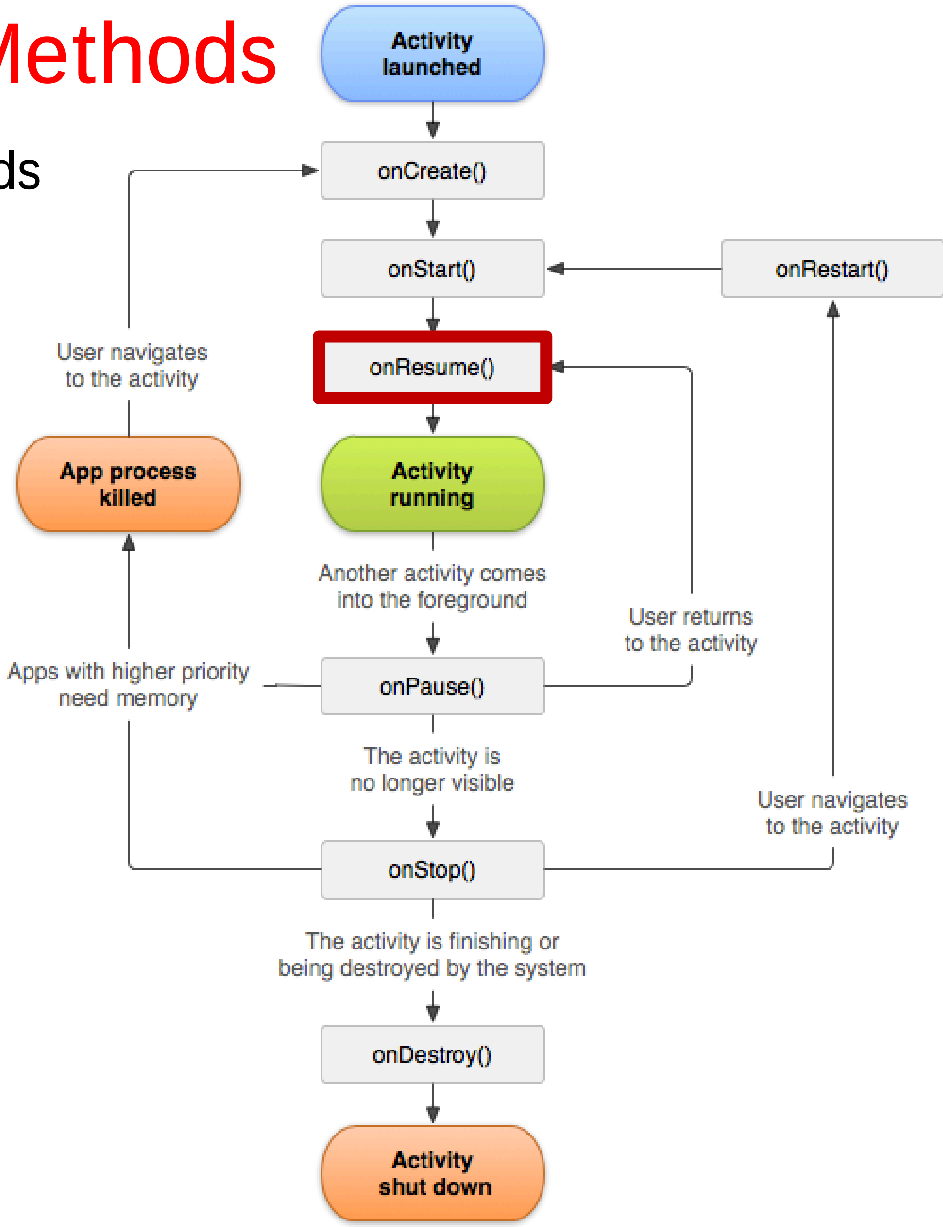
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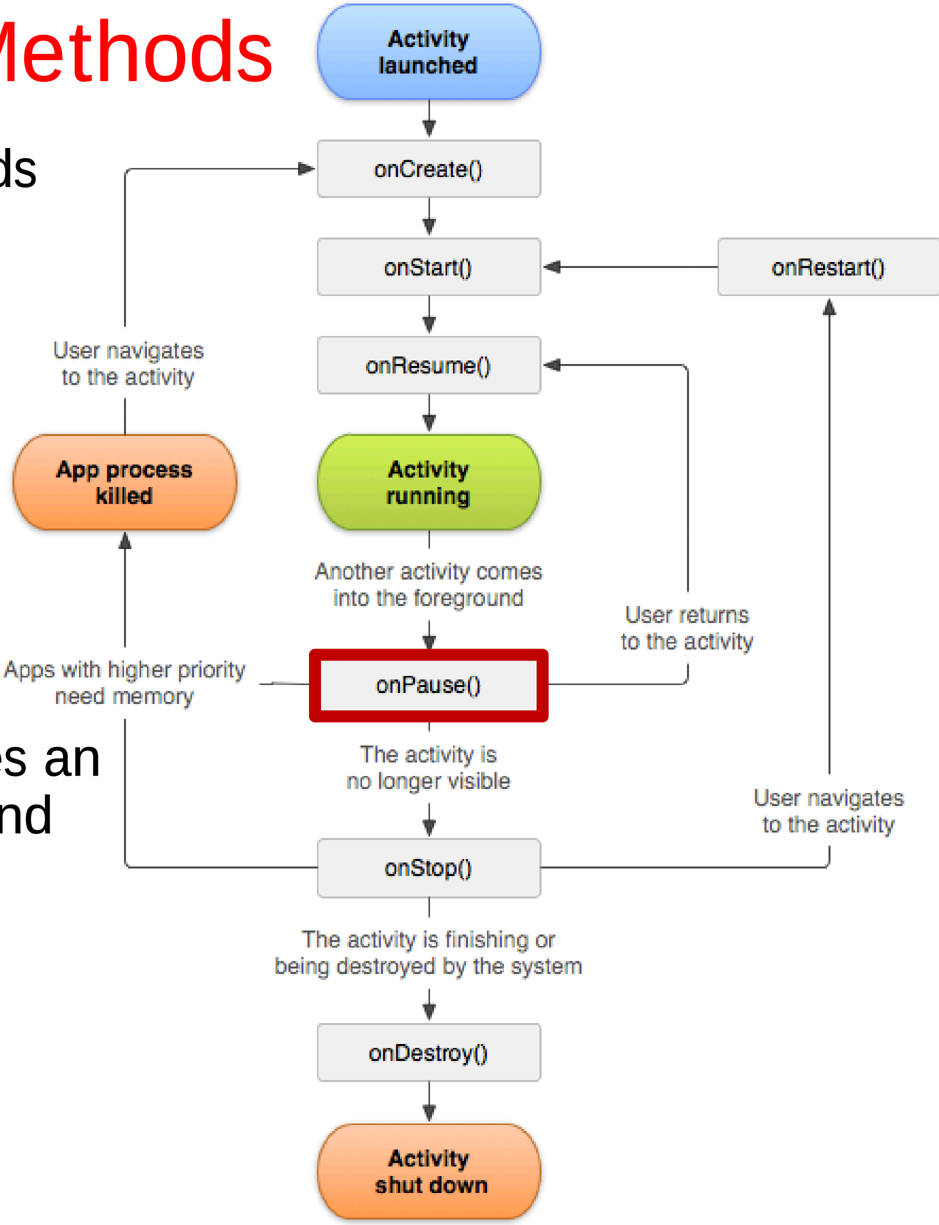
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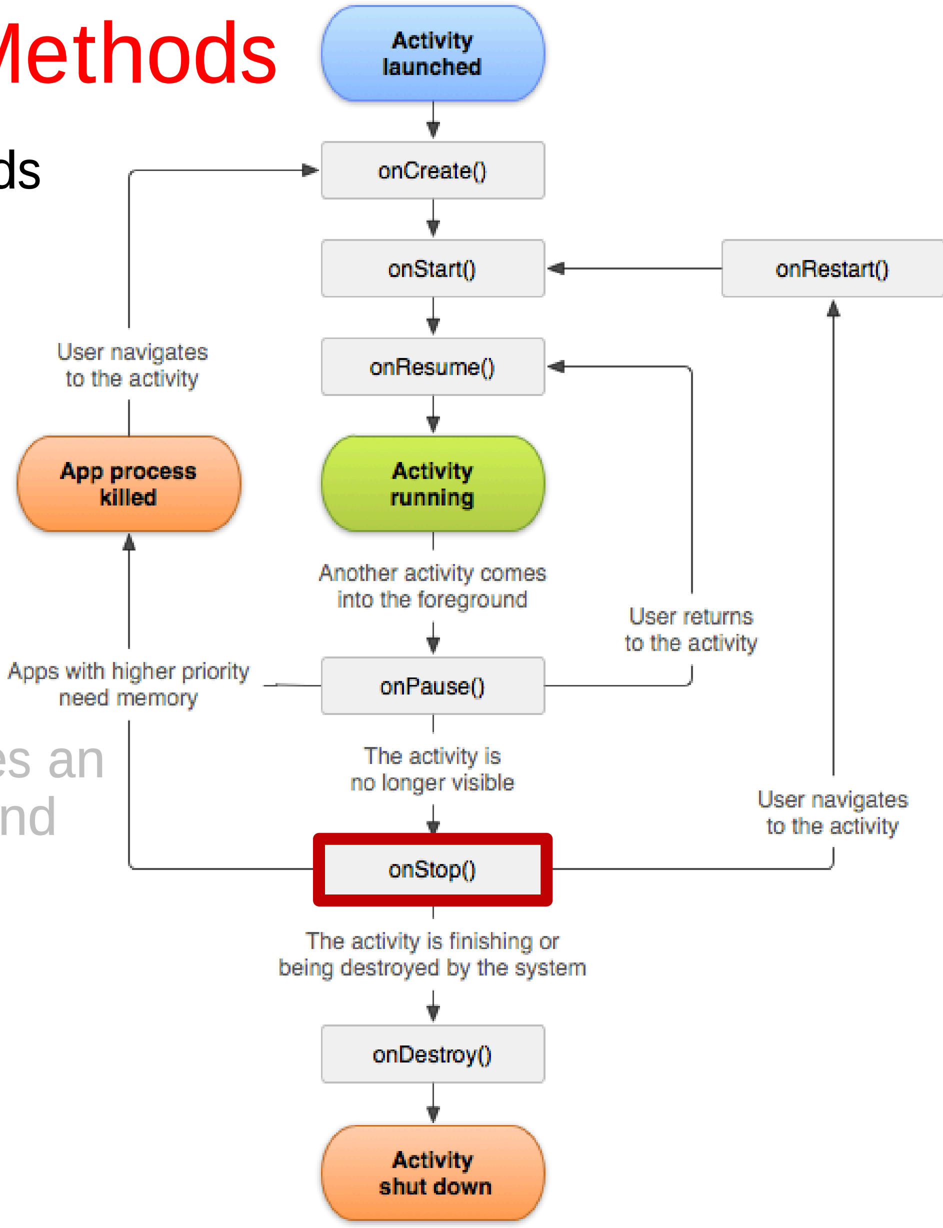
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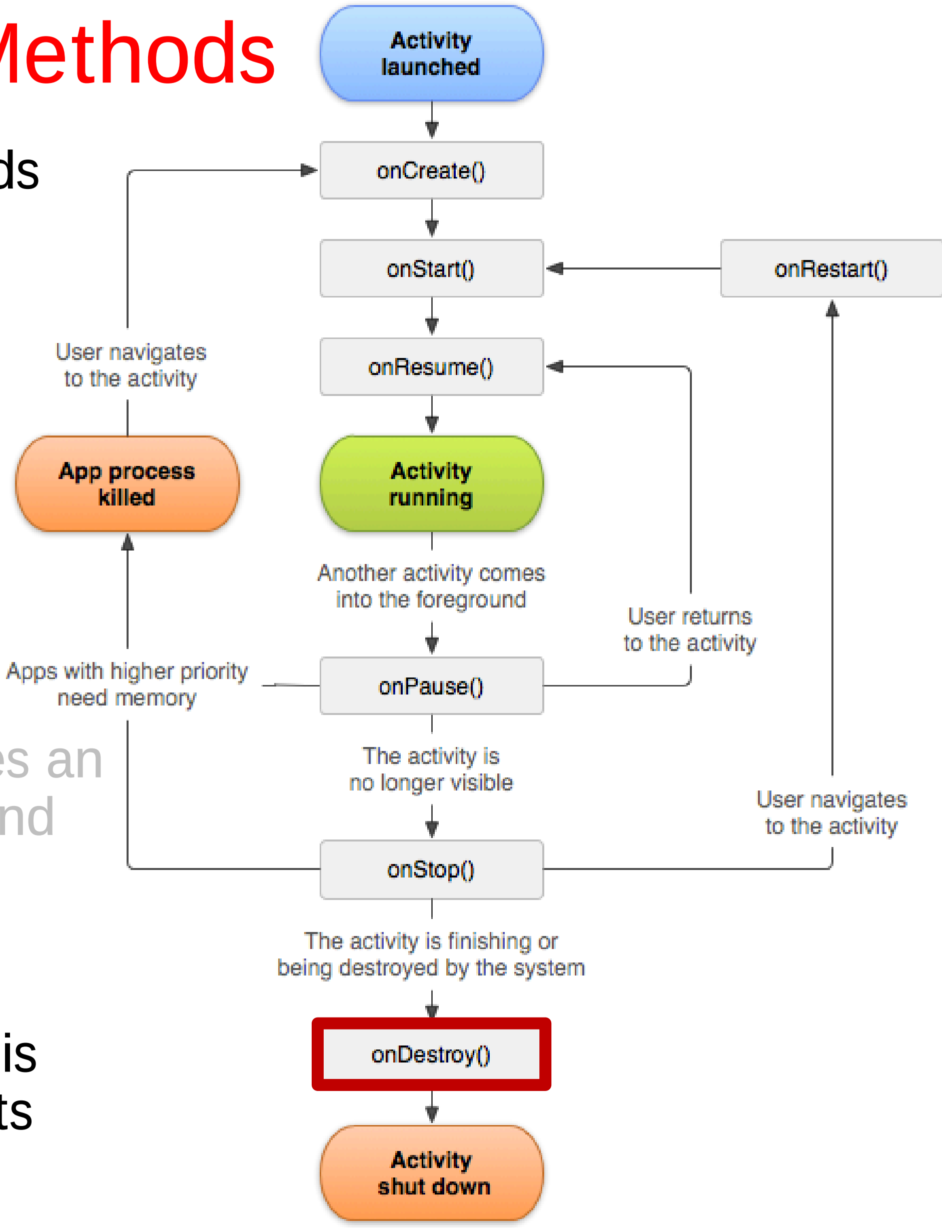
  - **onStop()** – called when user leaves an Activity for another
  - **onDestroy()** – called when Activity is being released & needs to clean up its allocated resources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See developer.android.com/reference/android/app/Activity.html for more info

Useful Helper Class for Activity Lifecycle Methods

```
public abstract class LifecycleLoggingActivity extends Activity {
```

Inherit from Activity class

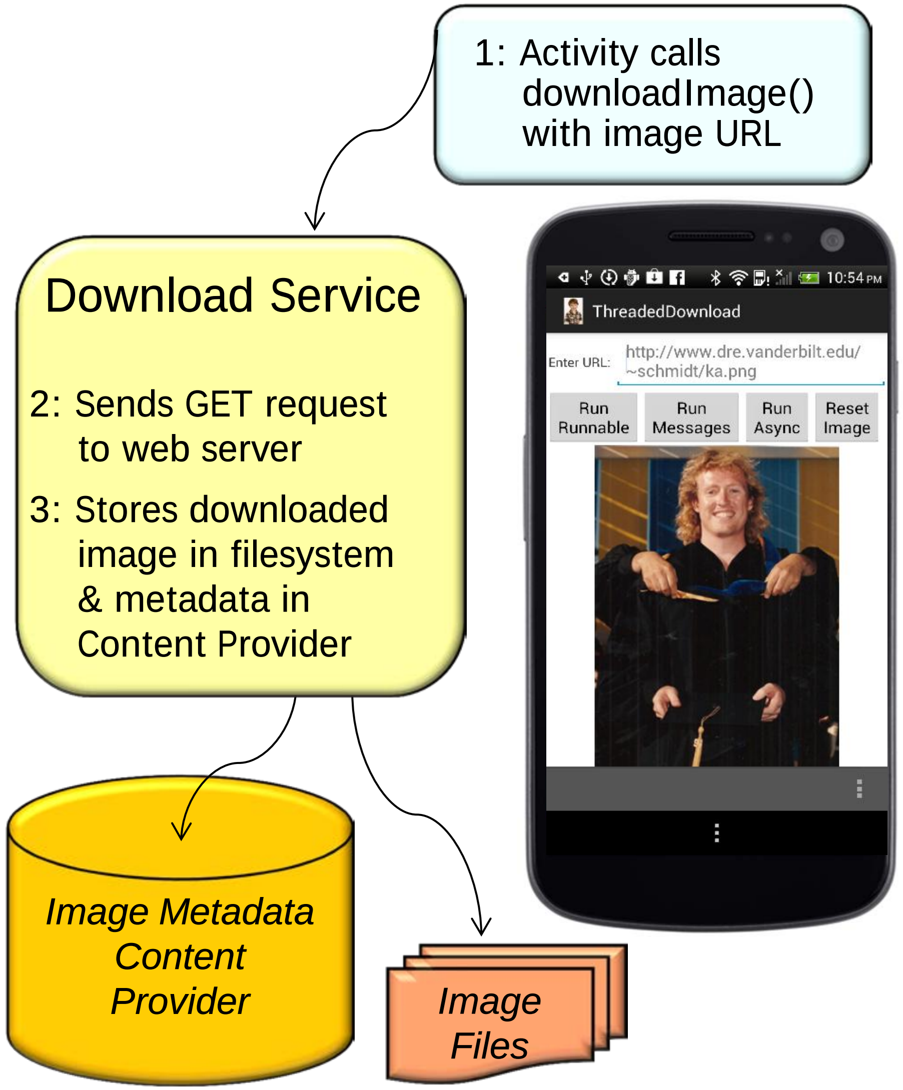
```
  public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    Log.d(getClass().getSimpleName(),
               "onCreate()");
    if (savedInstanceState == null)
      Log.d(getClass().getSimpleName(), "activity created anew");
    else
      Log.d(getClass().getSimpleName(), "activity restarted");
 }

 public void onStart() {
   super.onStart();
   Log.d(getClass().getSimpleName(), "onStart()");
 }
 ...
```

Automatically log lifecycle hook method calls

Note the "inversion of control" in the Android Activity framework

Recap of an Android Service

- A Service is an app component that can perform long-running operations in the background & does not provide direct access to the user interface
  - e.g., a service might handle network transactions, play music, perform file I/O, interact with a content provider, or run periodic tasks


1: Activity calls downloadImage() with image URL
Download Service
2: Sends GET request to web server
3: Stores downloaded image in filesystem & metadata in Content Provider
Image Metadata Content Provider
Image Files
10:54 PM
ThreadedDownload
Enter URL:
http://www.dre.vanderbilt.edu/~schmidt/ka.png
Run Runnable
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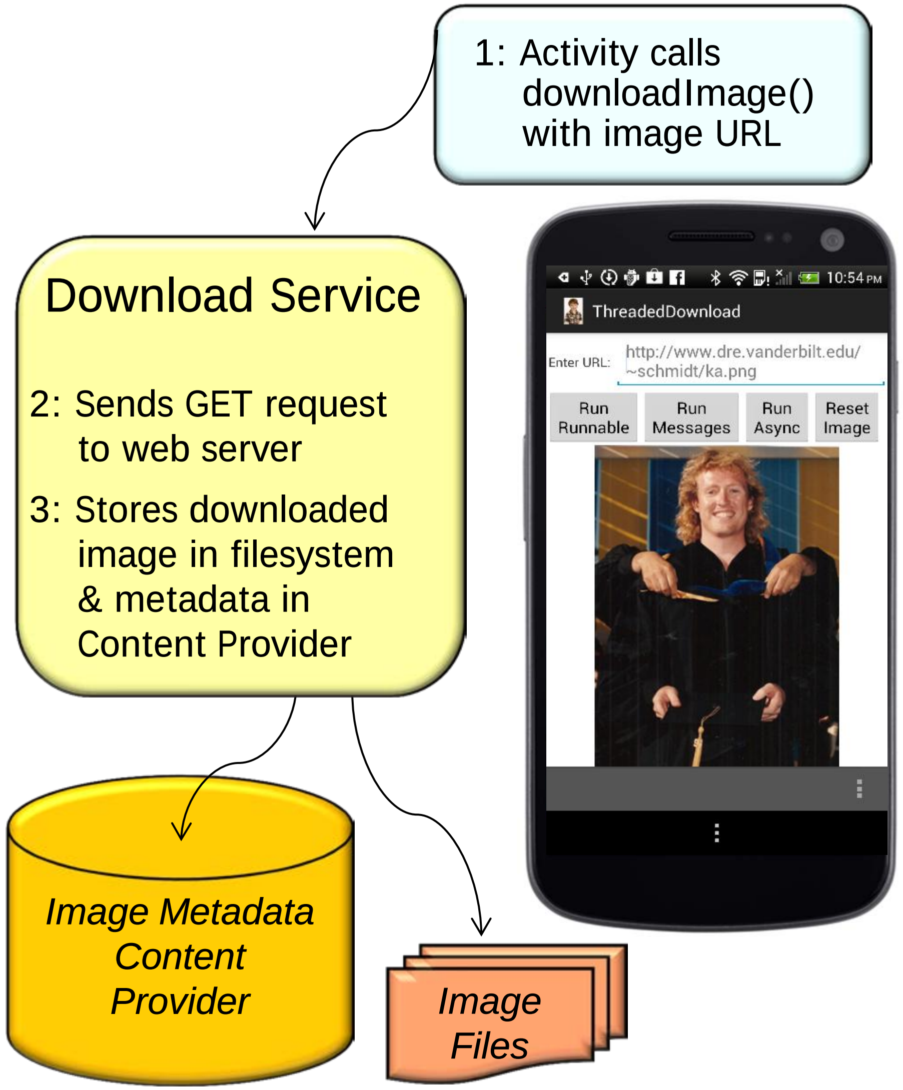
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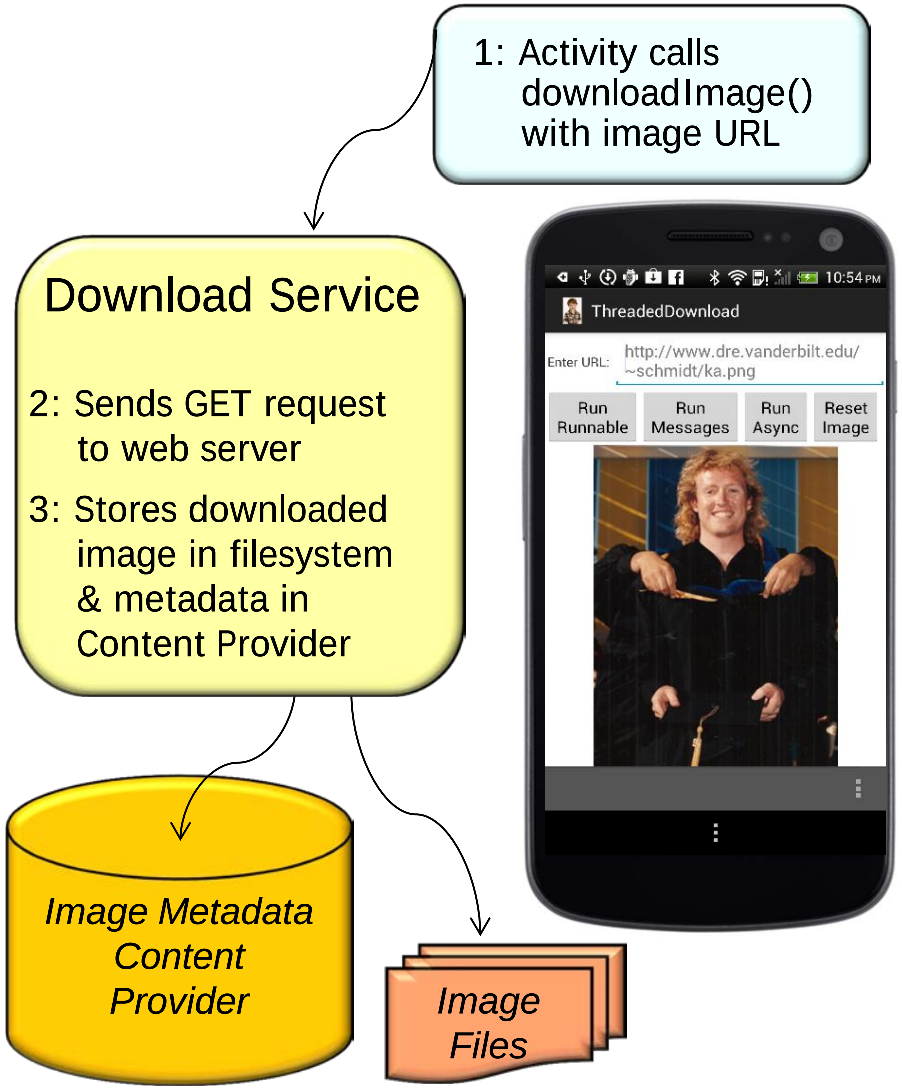
- Components can also bind to services to interact with them & perform local or remote IPC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See developer.android.com/guide/components/services.html for more info

Implementing a Service

- Implementing a Service is similar to implementing an Activity
    - e.g., inherit from Android Service class, override lifecycle methods, include Service in the config file AndroidManifest.xml, etc.

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

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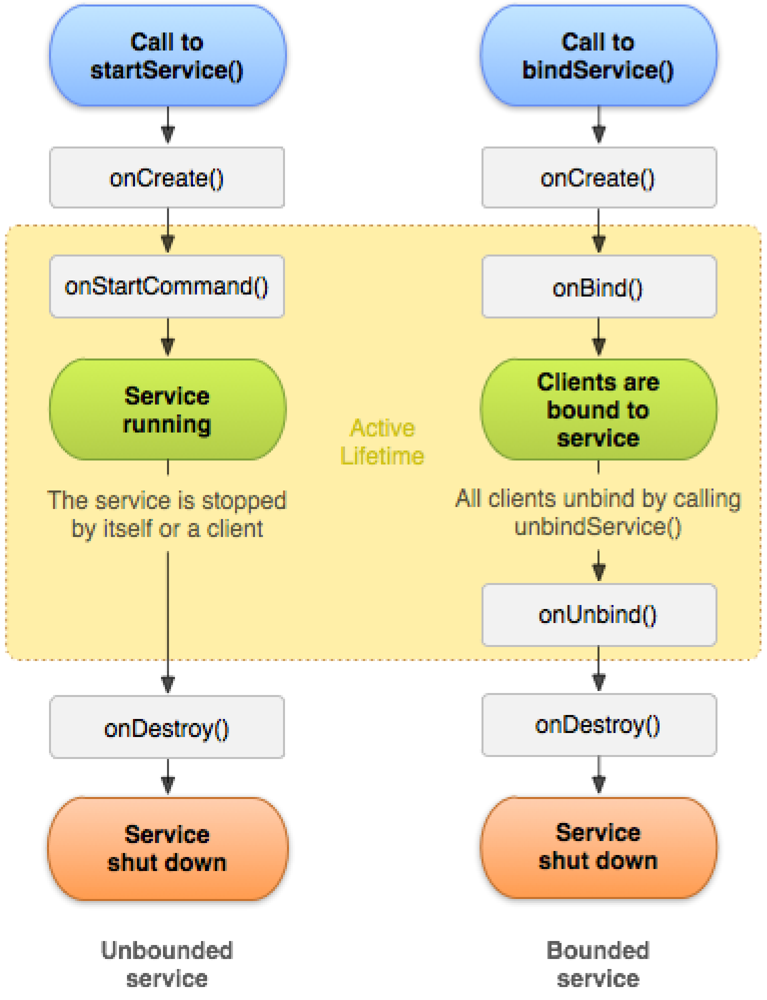

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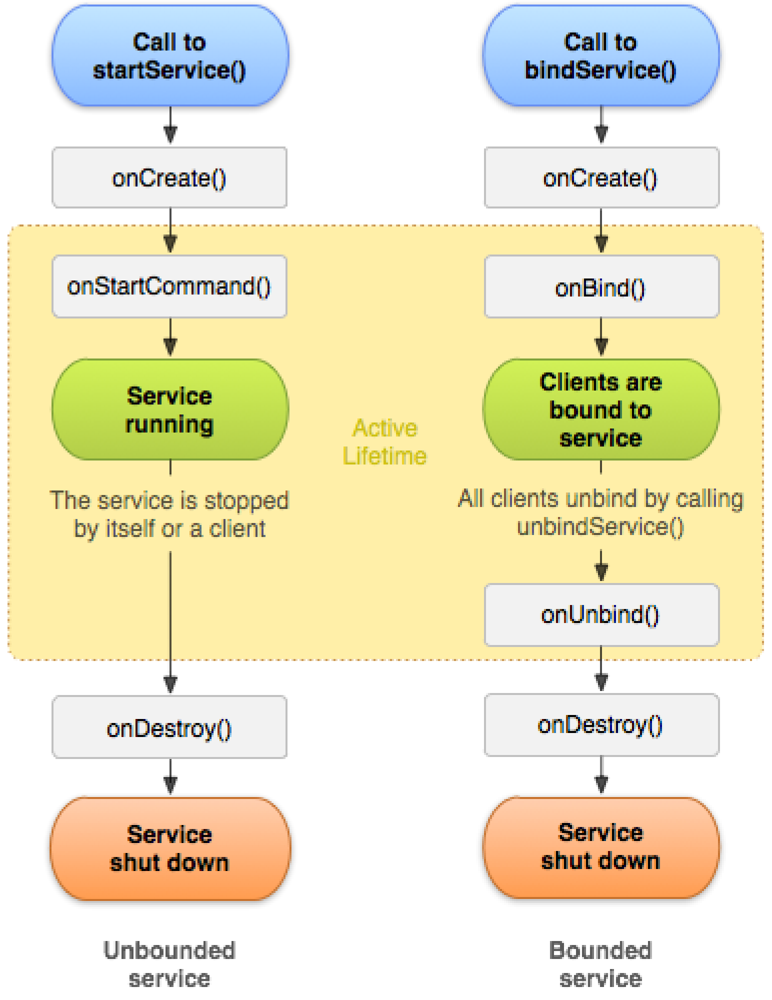
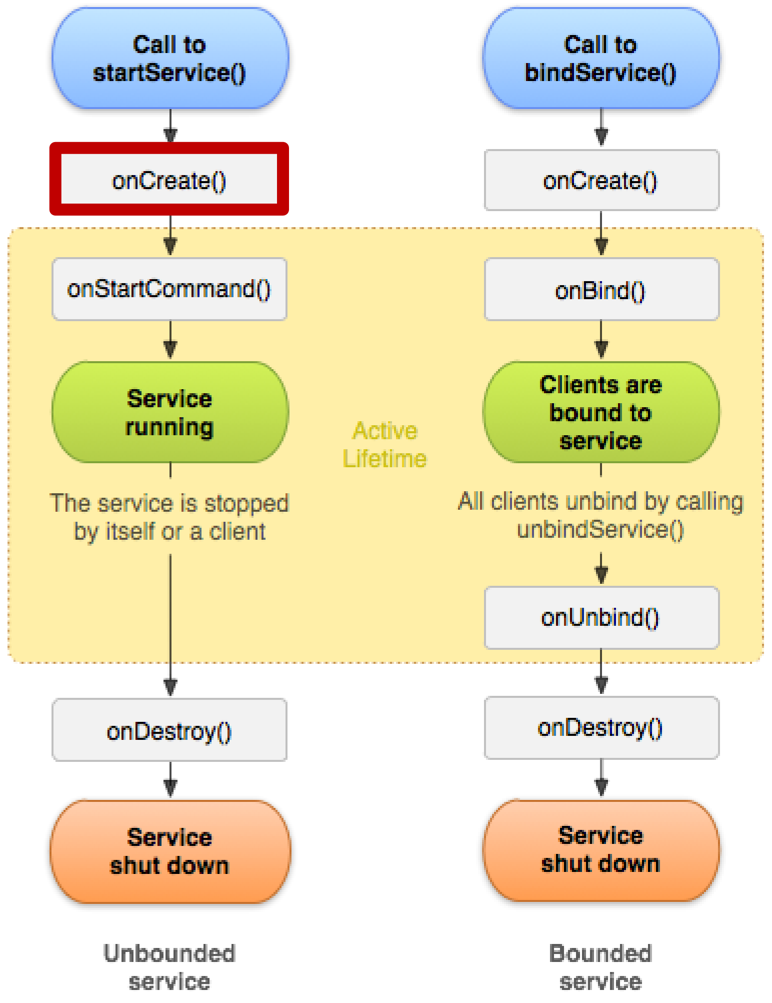


- **Commonality**: Provides common interface for performing long-running operations that don’t interact directly with the user interface
- **Variability**: Subclasses can override lifecycle hook methods to perform necessary initialization for *Started* & *Bound* Services

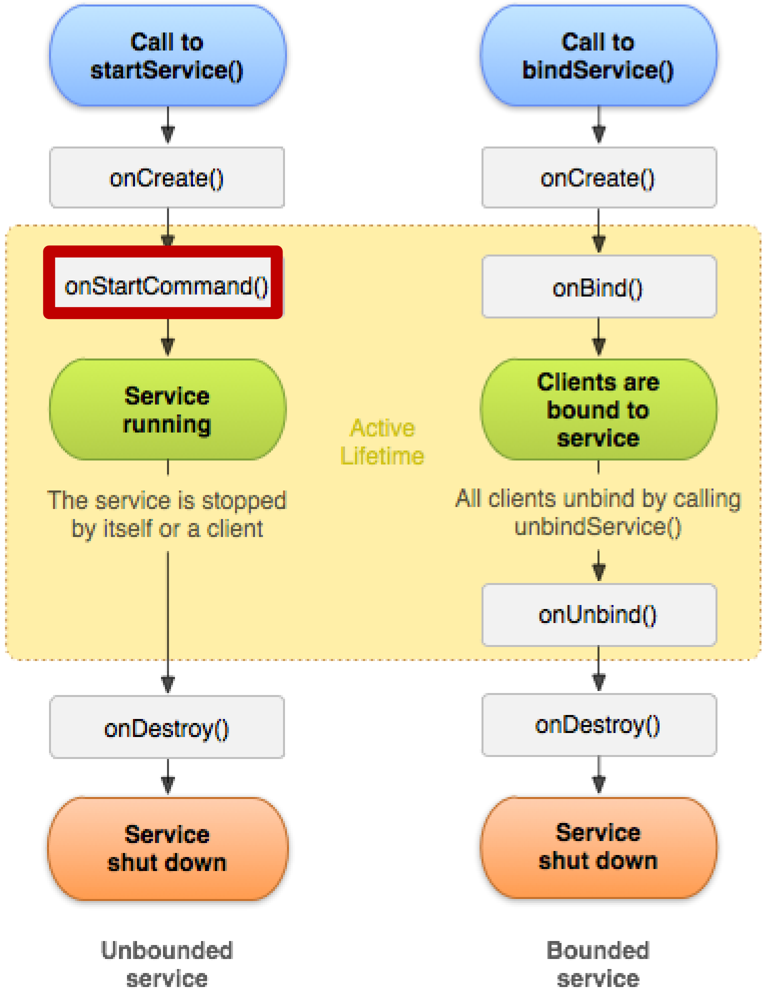
Service Lifecycle Hook Methods

- Services lifecycle methods include
  - **onCreate()** – called when Service process is created, by any means



Service Lifecycle Hook Methods

- Services lifecycle methods include
  - **onCreate()** – called when Service process is created, by any means
  - **onStartCommand()** – called each time Service is sent a command via startService()



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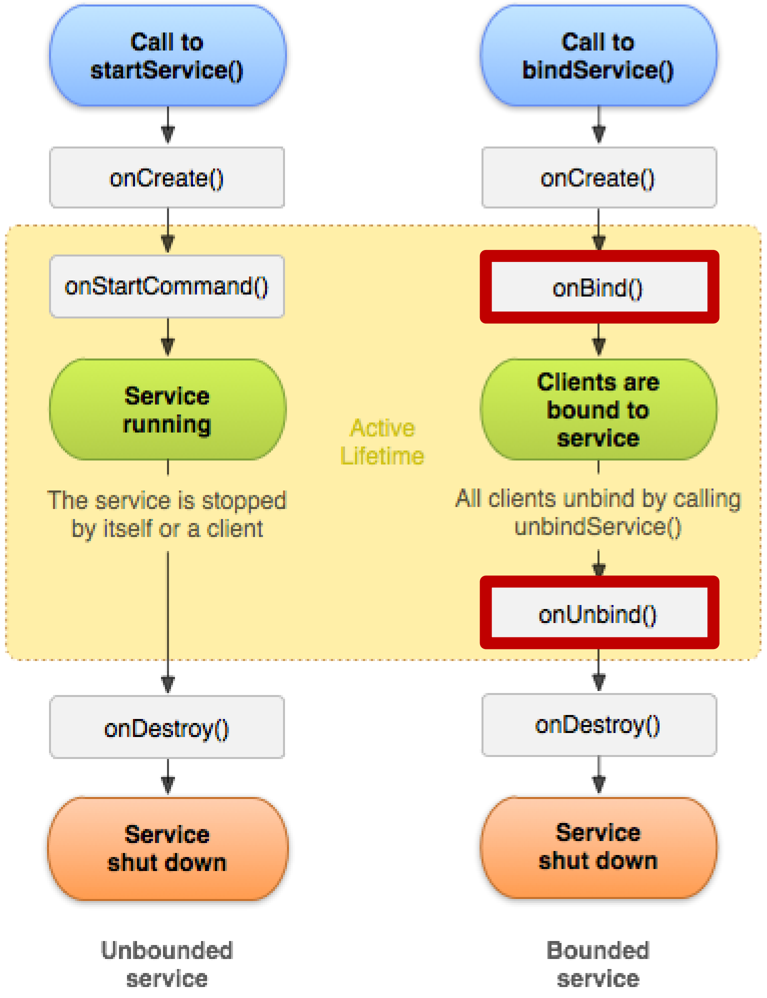

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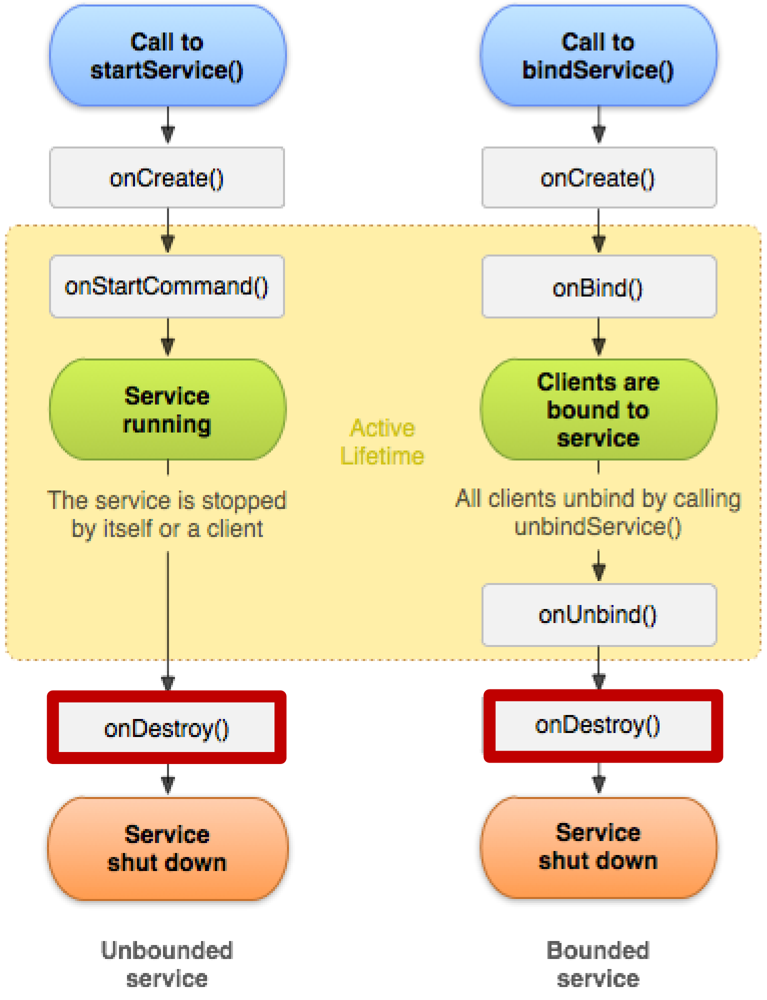
  - **onBind() / onUnbind** – called when a client binds/unbinds to Service via bindService()/unBindService()
  - **onDestroy()** – called as Service is being shut down to cleanup resources



Services do not automatically run in their own processes or threads

ThreadedDownloadService Example

```
public class ThreadedDownloadService extends Service {
```

Inherit from Service class

```
  public int onStartCommand(Intent intent, int flags, int startId) {
    super.onStartCommand( intent, flags, startId );
    String downloadType = intent.getCharSequenceExtra
                                ("DOWNLOAD_TYPE").toString();
      if (downloadType.equals("messenger"))
        threadMessengerDownload(intent);
      else if (downloadType.equals("pending_intent"))
        threadPendingIntentDownload( intent );
      else if (downloadType.equals("asynctask")
        asyncTaskDownload(intent);

      return Service.START_STICKY;
    }
```

Lifecycle hook method downloads image via various concurrency & IPC mechanisms

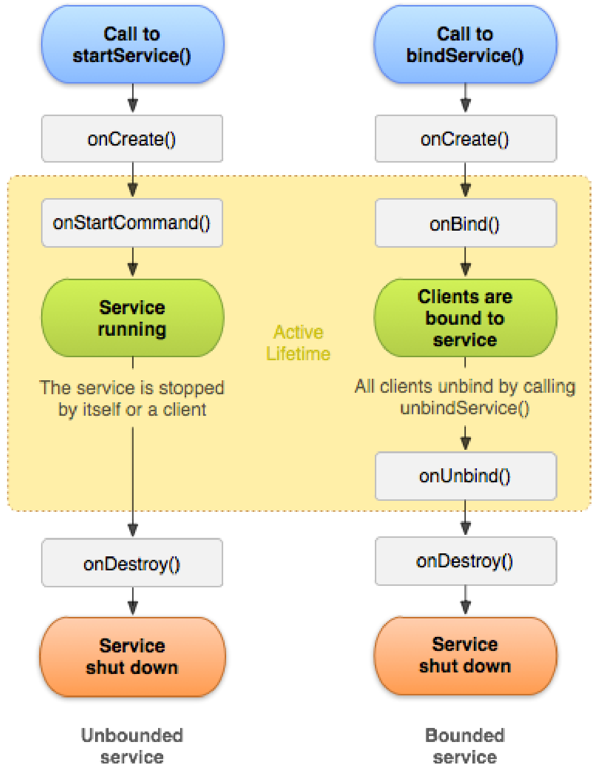
Instruct Android to run ThreadedDownloadService in its own process

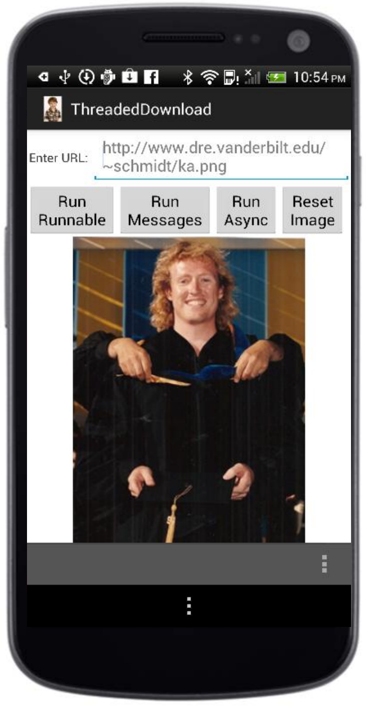
```
<service android:name="ThreadedDownloadService“
         android:process=":my_process"/>
```

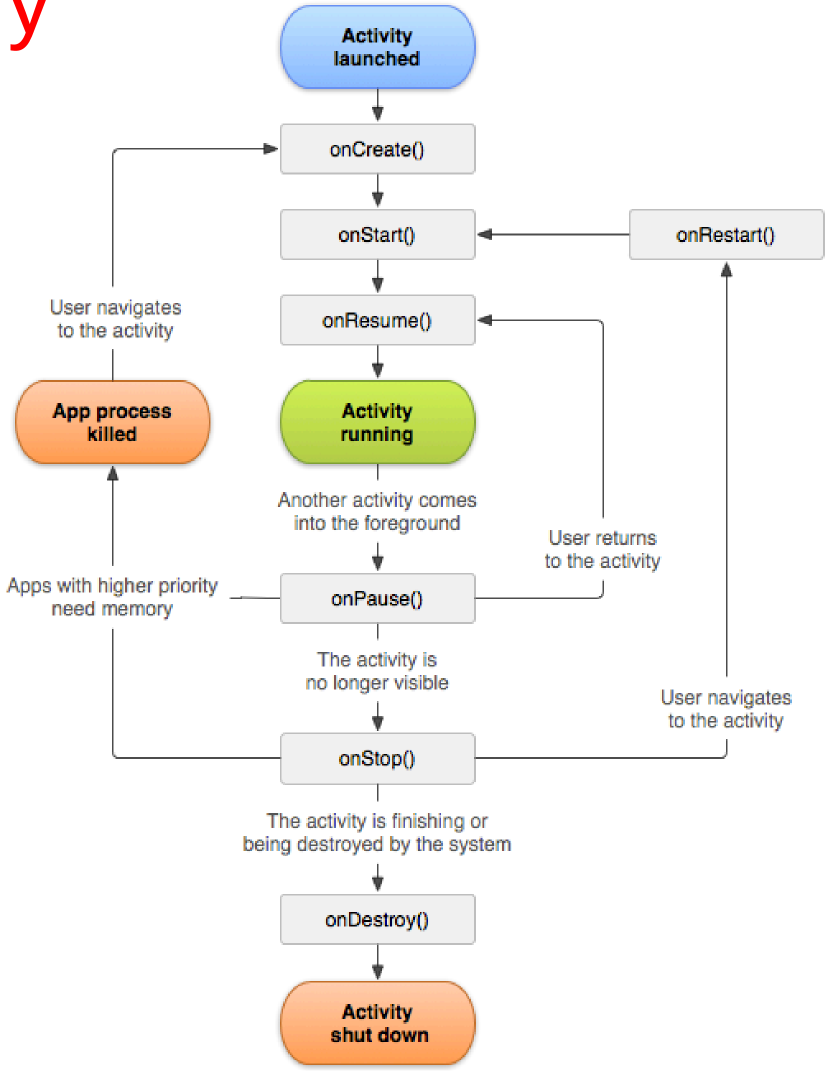
Note the “inversion of control” in the Android Service framework

Summary

- Android's framework components support inversion of control & embody many commonalities & variabilities of mobile app development



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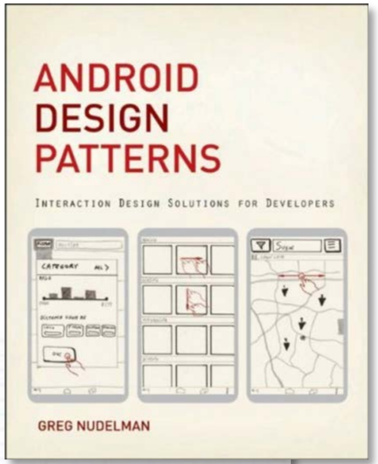
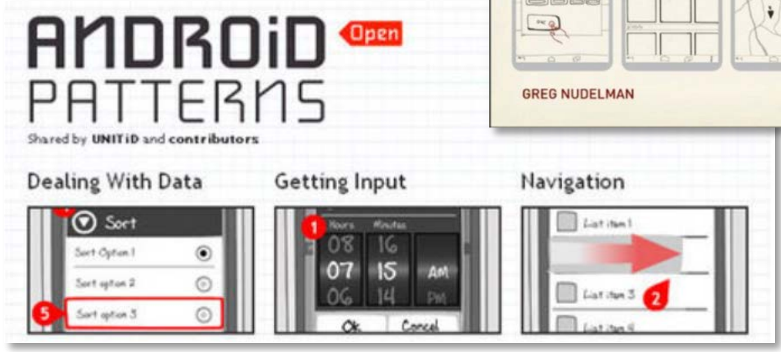
Summary

- Android's framework components support inversion of control & embody many commonalities & variabilities of mobile app development
- There are many patterns in Android
  - Both at the infrastructure & app levels


ANDROID DESIGN PATTERNS

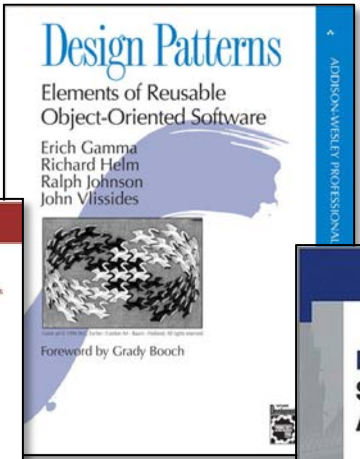
INTERACTION DESIGN SOLUTIONS FOR DEVELOPERS

GREG NUDELMAN


ANDROID Open PATTERNS

Shared by UNITiD and contributors

www.androidpatterns.com


Design Patterns

Elements of Reusable Object-Oriented Software

Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides

Foreword by Grady Booch

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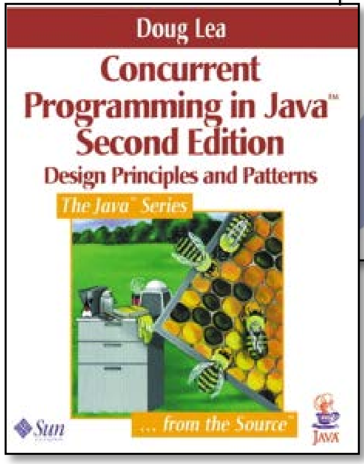
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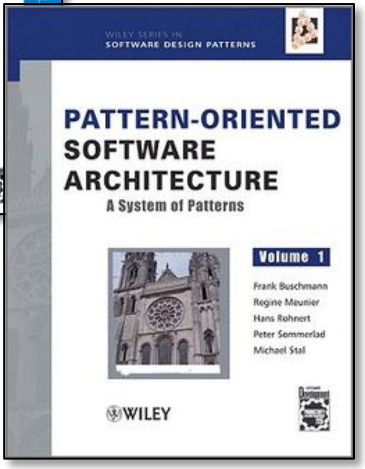
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