CPET 499/565 Mobile Computing Systems

Lecture Note 3

Smart Phones and OSs, Development Tools, Android Application Framework

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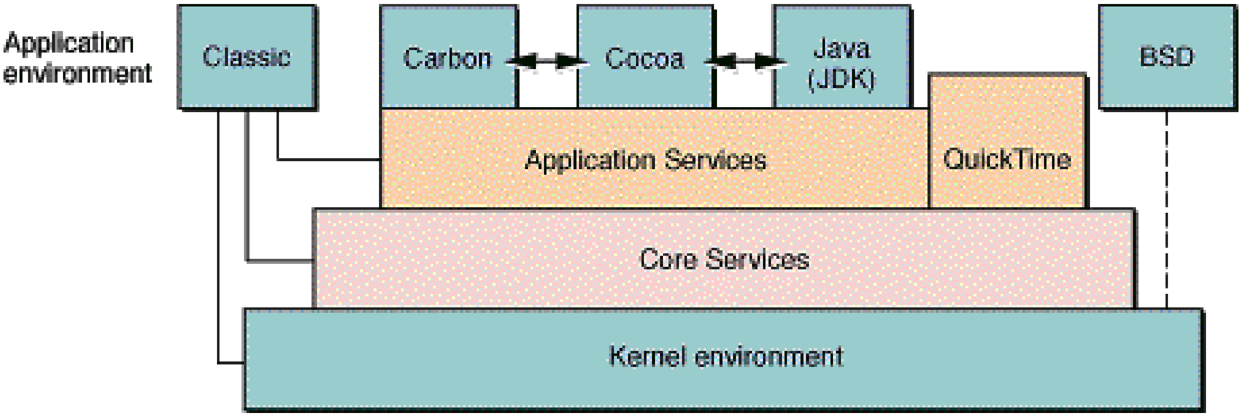
Mobile OS

- iPhone OS
- Android OS
- Windows Phone 8
- BlackBarry OS

iPhone OS Architecture

- iOS is a Unix based OS
- Based on proprietary Mach kernel and Darwin Core as Mac OS X
- BSD Unix
- File Systems
- I/O Systems
- Networking Components
- Main Features
    - Home screen
    - Folders
    - Notification Center
    - Default APPs
    - Multitasking
    - Switching Applications
    - Game Center

Kernel Architecture Overview, https://developer.apple.com/library/mac/documentation/Darwin/Conceptual/KernelProgramming/Architecture/Architecture.html



OS X Architecture

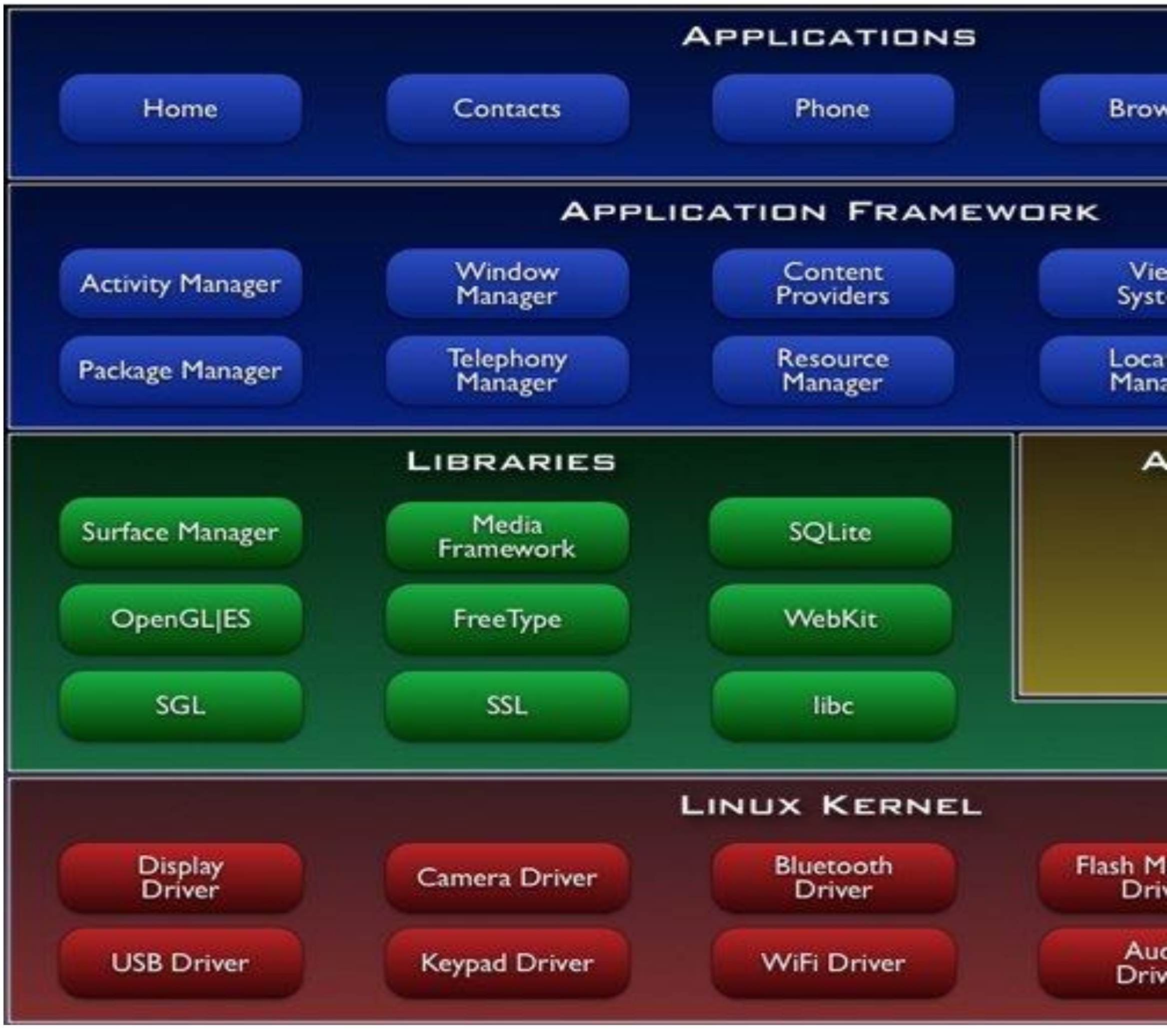
Microsoft Window Mobile OS

- Window Phone http://www.windowsphone.com/en-us
- What's new in Windows Phone 8.1 http://msdn.microsoft.com/en-us/library/windows/apps/dn632424.aspx

Android OS Architecture

- Created by Android Inc., as part of Google in 2005 for mobile devices: Tablets and Smartphone
- In 2007 Google formed an Open Handset Alliance with 86 hardware, software and telecom companies
- Development in Open Source – Source code is publicly available
- Developers are welcome to contribute via SDK
- Packages include Linux Kernel and Java-based application framework
    - Linux Kernel – for core system services: security, memory management, and process management
    - Runtime
        - Set of core libraries which supports Java functionality
        - The Dalvik Virtual Machine
        - Relying on Linux kernel for underlying functionalities such as threading …
- Libraries: C/C++ libraries
    - Media libraries, system C library, surface manager, 3D libraries, SQLite, etc
- Application Framework
    - An access layer to the framework APIs used by the core applications
    - Allow components to be used by the developers
- Main Features
    - Handset layouts
    - Storage
    - Connectivity – GSM/EDGE, CDMA, UMTS, Blouetooth, Wi-Fi, LTE, NFC, WiMax, etc
    - Messaging – SMS, MMS, C2DM (Android Cloud to Device Messaging)
    - Multiple language support
    - Web browser
    - Media support
    - Streaming media support
    - Additional hardware support
    - Multi-touch
    - Bluetooth
    - Video calling
    - Screen capture
    - External storage
- Android OS Versions, http://developer.android.com/about/index.html
    - 4.4 KitKat (2013), http://www.android.com/versions/kit-kat-4-4/
    - 4.3 Jelly Bean, http://www.android.com/versions/jelly-bean-4-3/
    - 4.2 Jelly Bean, http://www.android.com/versions/jelly-bean-4-2/
    - 4.1 Jelly Bean (2012)
    - 4.0 Ice Cream Sandwich (2011)
    - 3.0-3.2 – Honeycomb (2011)
    - 2.3 – Gingerbread (2010)
    - 2.2 – Froyo (2010)

    - 2.0-2.1 – Éclair (2009 -)
    - 1.6 – Donut (2009)
    - 1.5 – Cupcake (2009)



References

- Android (Operating System), http://en.wikipedia.org/wiki/Android_(operating_system)
- Open Handset Alliance, http://www.openhandsetalliance.com/
    - Android Open Source Project (Video), 2008, https://www.youtube.com/watch?v=7Y4thikv-OM
- Mobile Operating System, http://en.wikipedia.org/wiki/Mobile_operating_system
    - Combines features of a typical personal computer's OS with other features including:
        - Touchscreen, Cellular, Bluetooth, Wi-Fi, GPS mobile navigation, Camera, Video Camera, Speech recognition, Voice recorded, Music Player, Near field communication, Infrared blaster
- Introducing Android, http://www.android.com/about/
- List of Features in Android, http://en.wikipedia.org/wiki/List_of_features_in_Android
- Smartphone OS Showdown, by Sascha Segan, 2013/3/27, http://www.pcmag.com/article2/0,2817,2417059,00.asp

- Smartphone OS Shootout: Android vs. iOS vs. Windows Phone, March 2011, http://www.computerworld.com/article/2506829/mobile-wireless/smartphone-os-shootout-android-vs-ios-vs-windows-phone.html

SmartPhone Hardwares and Features

- 2014 Best Smartphone Reviews and Comparisons, http://cell-phones.toptenreviews.com/smartphones/
  - Samsung Galaxy S5, Note
  - HTC One
  - LG G2, G Flex
  - Apple iPhone
  - Nokia Lumia
  - Sony Xperia
  - Google Nexus
- **Ratings: Design, Camera, Battery Life, Internal Specs, Features, Carriers**
  - Design
    - Usability Score
    - Operating System
    - Screen Size (inches)
    - Display Resolution
    - Pixel Density (PPI)
    - Screen Technology
    - Weight
    - Dimensions
  - Internal Specs
    - Processor Architecture: 32-bit, 64-bit (iPhone)
    - Processor Speed (GHz)
    - Number of Cores (2 or 4)
    - RAM (1, 2, or 3 GB)
    - Built-in Storage (16/32/64 GB)
    - Expandable Storage
  - Features
    - 4G LTE
    - Telhering/Wi-Fi Hotspot
    - Bluetooth 4.0
    - Gyroscope
    - Compass
    - Accelerometer
    - Near Field Communication
    - Infrared Blaster
    - FM Radio
    - Fingerprint scanner
    - Water resistant
    - Included Headphones

References

- 2014 Best Smartphone Reviews and Comparisons, http://cell-phones.toptenreviews.com/smartphones/
- The Ten Best Smartphones, http://www.pcmag.com/article2/0,2817,2367064,00.asp

Android Architecture

- Bootloader
- Boot Image
- System image
- Recovery image
- Radio image

Hardware

- MPU (MCU)
- RAM/ROM
- Screen
- Others

User Inputs

- Touch screen technologies
  - Resistive
  - Capacitive
  - Surface acoustic wave

Sensors

- Accelerometer
- Magnetic field sensor
- Orientation sensor
- Temperature sensor
- Proximity sensor
- Light sensor

Sensors Overview, http://developer.android.com/guide/topics/sensors/sensors_overview.html

- Built-in Sensors for measuring Motion, Orientation, and various environmental condition

Development Tools

Mobile Devices – An Introduction to the Android Operating Environment Design, Architecture and Performance Implications, http://people.stfx.ca/x2011/x2011bhd/391/m_78_3.pdf

Android OS

- Android Open Source Project, http://source.android.com/
- Developers, http://developer.android.com/index.html
  - Design, http://developer.android.com/design/index.html
  - Develop, http://developer.android.com/develop/index.html
    - Android SDK download, http://developer.android.com/sdk/index.html

Android OS Major Components

- Android: A Complete Overview of Android OS Components, http://android.blogvasion.com/2012/12/android-complete-overview-of-android-os.html

Introduction to Android, http://developer.android.com/guide/index.html

Android Application Framework

- Provided in android.jar file
- **Android SDK** is made up of the following packages

Top-Level Package	Purpose
android.*	Android application fundamentals
dalvik.*	Dalvik Virtual Machine support classes
java.*	Core classes and generic utilities for networking, security, math, etc
javax.*	Java extension classes: encryption support, parsers, SQL, etc
junit.*	Unit testing support
org.apache.http.*	HTTP protocol
org.json	JavaScript Object Notation (JSON) support
org.w3c.dom	W3C Java bindings for the Document Object Model core (XML and HTML)
org.xml.sax.*	Simple API for XML (SAX) support for XML
org.xmlpull.*	High-performance XML parsing

- Android Application Framework FAQ, http://developer.android.com/guide/faq/framework.html
- Google APIs Add-On - an extension to the Android SDK, https://developers.google.com/android/add-ons/google-apis/
  - The Maps external library
  - The USB Open Access Library
  - A sample Android application called MapsDemo
  - Full Maps library documentation
- Android documentation references, http://developer.android.com/index.html

Application Fundamentals, http://developer.android.com/guide/components/fundamentals.html

- 4 types of app components
  - Activities
    - An activity represents a single screen with user interface
      - Email app
      - Camera app
  - Services (run on background)
  - Content providers
    - Manage a shared set of app data
    - Each component is activated by an asynchronous message called “Intent”
    - The “Intent” can contain a Bundle of supporting information describing the component
  - Broadcast receivers

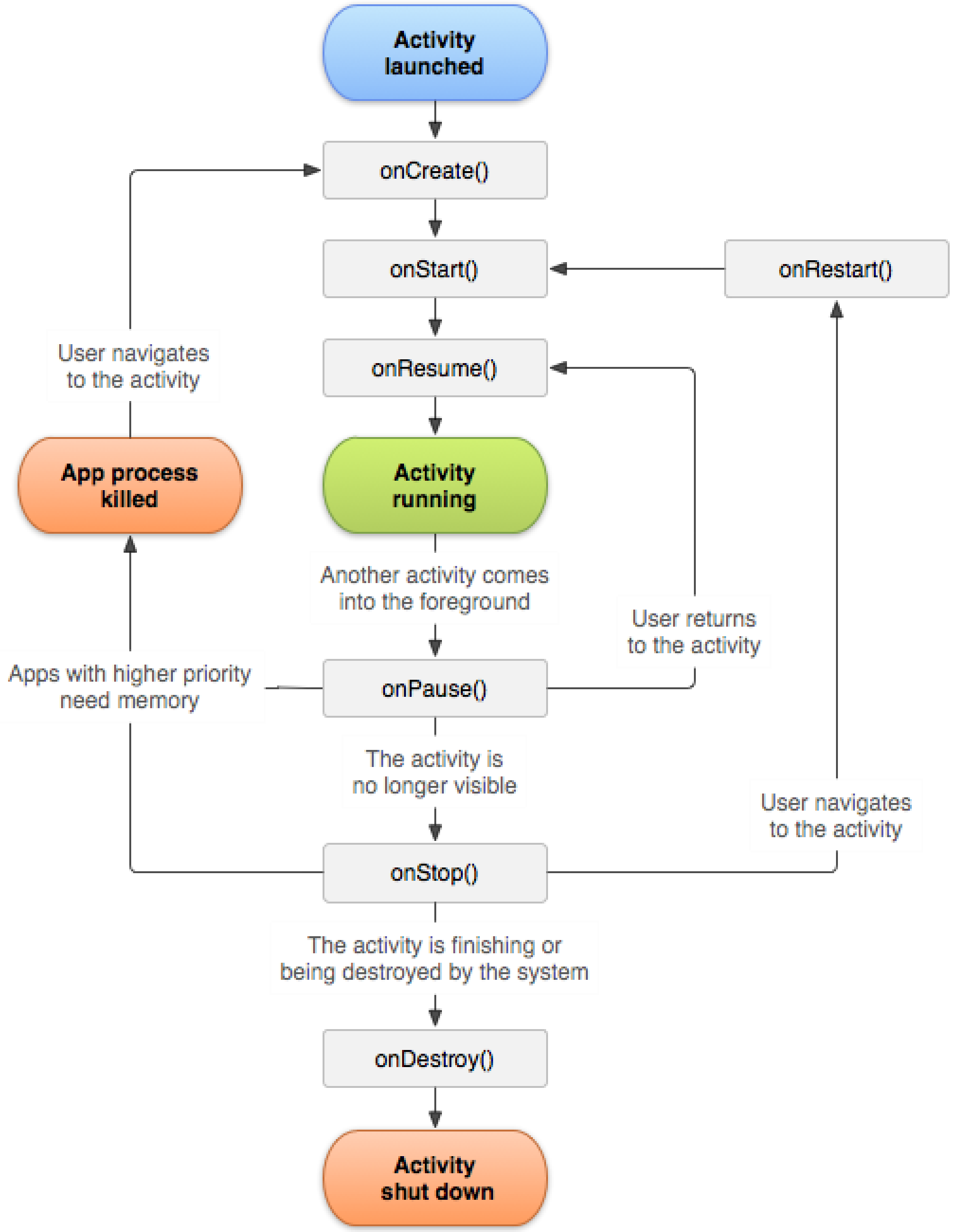
Android App Components, http://developer.android.com/guide/components/fundamentals.html

- **Activity**, http://developer.android.com/reference/android/app/Activity.html
  - **public class Activity extends ContextThemeWrapper implements ComponentCallBacks** …; http://developer.android.com/reference/android/app/Activity.html
  - An android application is a collection of tasks, each of which is called an Activity
  - An activity represents a single screen with a user interface
  - **Lifecycle**: Getting created => Focused => Defocused => Destroyed

- **Context**, http://developer.android.com/reference/android/content/Context.html
    - **public abstract class Context extends Object**
    - It allows access to application-specific resources and classes
    - The central command center for an Android application-level operations such as
        - Launching activities
        - Broadcasting Intents
        - Receiving Intents
    - All application specific functionality can be accessed through the Context
- **Intent**, http://developer.android.com/reference/android/content/Intent.html
    - **public class Intent extends Object implements Parcelable Cloneable**
    - An abstract description of an operation to be performed.
    - An Intent is recognized as a request to do something with late runtime binding between the code in different applications.
    - The Android OS uses an asynchronous messaging mechanism to match task requests with the appropriate Activity
- **Service**, http://developer.android.com/guide/components/services.html
    - An application component for performing long-running, background operations that do not provide a user interface.
    - Tasks that do not require user interaction can be encapsulated in a service.
    - Most useful when the operations are lengthy (offloading time consuming processing) or need to be done regularly (such as checking a server for new mail)

Performing Application Tasks with Activities

- **Activity class**, http://developer.android.com/reference/android/app/Activity.html


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

- An Example – A simple **game** application might have the following 5 xActivities
    - Startup/Splash Activity
        - Main Menu Activity
            - Game Play Activity
            - High Score Activity
            - Help/About Activity
- Lifecycle of an Android Activity
- More Examples
    - Using Activity Callbakcs to manage application state and resources
    - Initializing static Activity data in onCreate()

    - Initializing and retrieving Activity data in onResume()
    - Stopping, saving, and releasing Activity data in onPause()
    - Avoiding Activity objects being Killed
        - Under low-memory operation, OS can kill the process for any Activity that has been paused, stopped, or destroyed.
    - Saving Activity state into a bundle with onSaveInstanceState()
    - Destroy static Activity data in onDestroy()

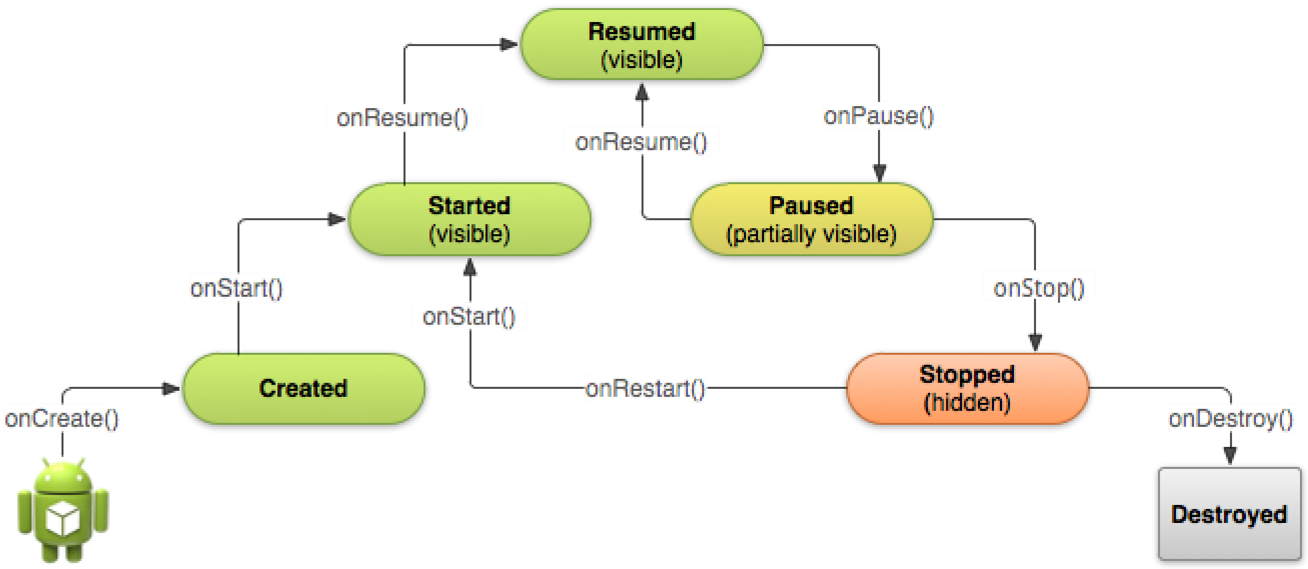
Using Activity callbacks to manage Application state and resources
Activities

- An activity specify an interaction with a user and is responsible for managing user interaction with a screen/window of information
- A window is automatically created with each activity
- Abstract class "Activity"
    - OnCreate() method .... The entry point of an activity
    - setContentView()
    - onStart()
    - onResume()
    - onPause()
    - onStop()
    - onDestroy() … activity exits
- Using Activity Life Functions
    - Screen orientation change
        - Destroy and recreate the activity from scratch
    - Press home key
        - Pause the activity but does not destroy it
    - Press application icon
        - Might start a new instance of the activity, even if the old one was not destroyed.
    - Letting the screen sleep
        - Pause the activity
        - The screen awakening resume the activity
- Forcing Single Task Mode
    - AndroidMainfest.xml
        - android:launchMode="singleInstance"
        - android:launchMode="singleTask"
- Forcing Screen Orientation
    - Accelerometer sensor
    - Portrait or landscape mode
        - android:screenOrientation="portrait"
        - android:screenOrientation="landscape"
    - If you want to let the application handle orientation
        - android:configChanges="orientation|keyboardHidden"
- Saving & Restoring Activity Info
    - onSaveInstanceState()
- Multiple Activities
    - Examples
        - Game has two activities: Game Screen and High-Score Screen

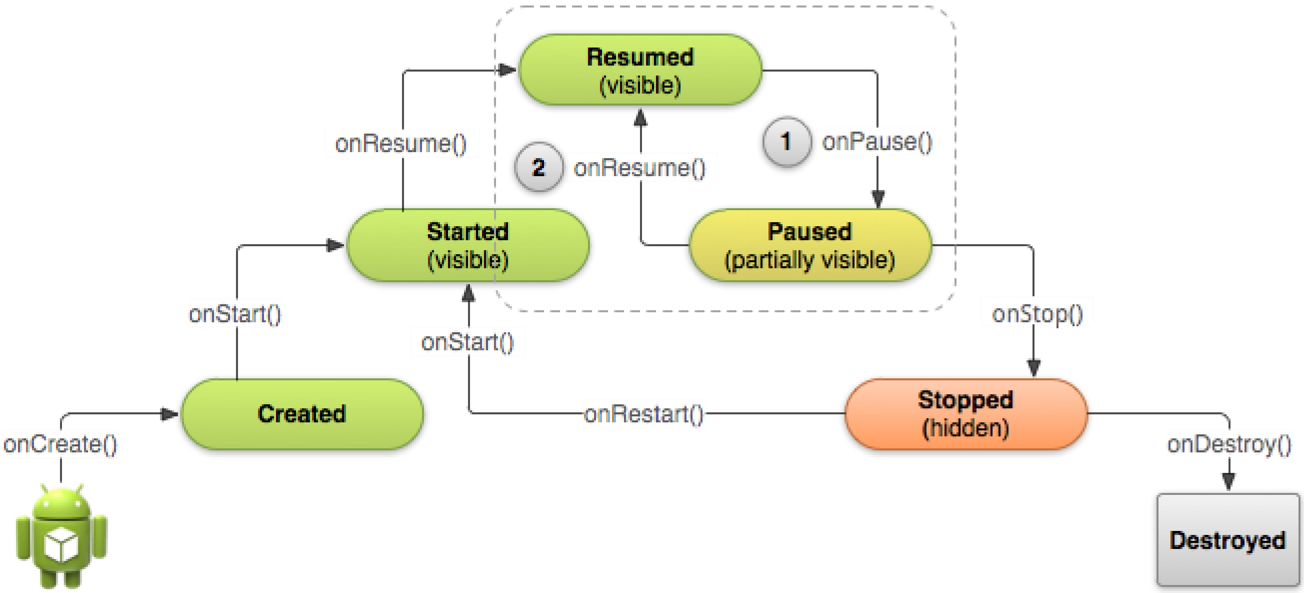
        - Notepad has three activities:
            - View a list of notes
            - Read a selected note
            - Edit a selected or new note
    - Using Buttons and TextView
    - Launching a Second Activity from an Event
    - Launching an Activity for a Result Using Speech to Text
    - Implementing a List of Choices
    - Using Implicit Intents for Creating an Activity
    - Passing Primitive Data Types between Activities

Managing the Activity Life Cycle, http://developer.android.com/training/basics/activity-lifecycle/index.html

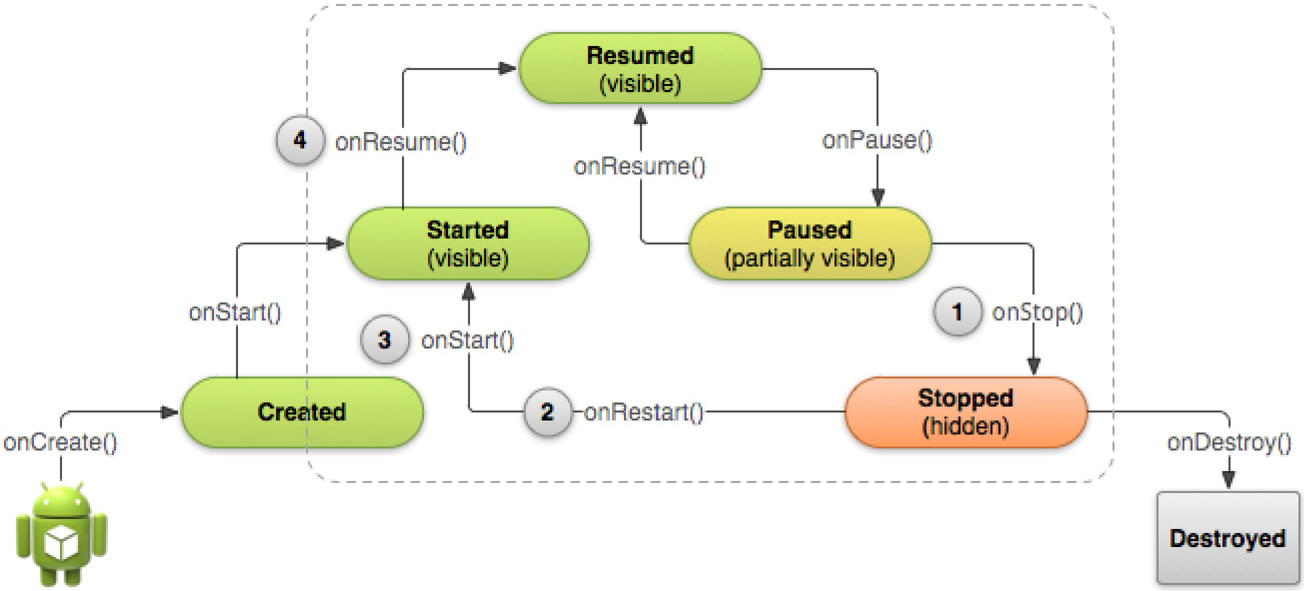
Starting an Activity



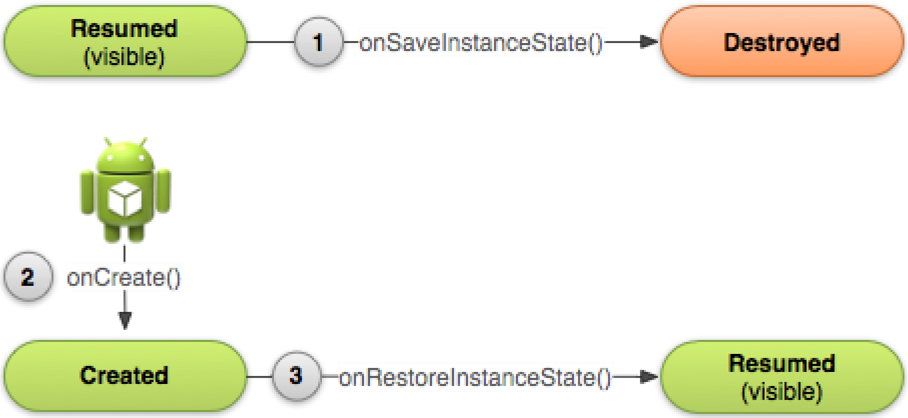
Pausing and Resuming an Activity



Stopping and Restarting an Activity



Recreating an Activity



```
public class MyActivity extends Activity{
        protected void onCreate(Bundle savedInstanceState);
                // Initialize static Activity data
        protected void onStart();
        protected void onRestart();
                // Bring activity to Foreground
        protected void onResume();
                //Bring activity to Foreground
                // Appropriate place for placing/starting Audio, Video, and Animators
        protected void onPause();
                // Pushed down the current Activity to the Activity Stack
                // Should stop any Audio, Video, and Animators
                //Deactivate resources such as a database Cursor object
                //Last chance for clean-up any resources it does not needed while in the background
                //Need to save any uncommitted data here, in case the application does not resume
        protected void onStop();
        protected voidonDestroy();
        }
```

Using the Application Context

- **Context class**, http://developer.android.com/reference/android/content/Context.html
- The application Context is the central location for all top-level application functionalities.
    - Retrieving the Application Context
    - Retrieving the Application Resources
    - Accessing Application Preferences
    - Accessing other Application Functionalities
        - Launch **Activity** instances
        - Retrieve assets packaged with the application
        - Request a system service (for example: a location service)
        - Manage private application files, directories, and databases
        - Inspect and enforce application permission
- public abstract class Context extends Object

- Inherited Methods from class: java.lang.Object
- Constants
- Public constructors – Context()
- Public Methods
    - **getApplicationContext()** method – retrieving the Application Context
    - **getResources()** method – retrieving Application Resources
    - **getSharedPreferences()** method – retrieve Application Preferences
    - ... etc

Managing Activity Transitions with Intents

- **public class Intent**, http://developer.android.com/reference/android/content/Intent.html
- Can be used with startActivity() to launch an Activity, and appropriate finish() methods
- Examples
    - sendBroadcast(Intent intent) to send it to any interested BroadcastReceiver components
    - startService(Intent) or bindServiceIIntent, ServiceConnection, int) to communicate with a background Service
- Other Examples
    - Transitioning between Activities with Intents
    - Launching a new Activity by class name
    - Creating Intents with action and data (action/data pair)
    - Launching an Activity belonging to another application
        - Customer Relationship Management (CRM) app
    - Passing additional information using Intents
    - Organizing Activities and Intents in an application using Menus

Launching an Activity belonging to another application

- Customer Relationship Management (CRM) launch the **Contacts** application
    - to browse the **Contact database**
    - Choose a **specific contact**
    - Return that contact's **unique ID**
- Launch Phone_Dialer app with a specific number
  Uri number = Uri.parse(tel:2604816339);
  Intent dial = new Intent(Intent.ACTION_DIAL, number)
  startActivity(dial);

Intents List: Invoking Google applications on Android Devices (Target Application/Intent URI), http://developer.android.com/guide/appendix/g-app-intents.html

- Browser (view, web search)
- Dialer (call)
- Google Maps (view)
- Google Streetview
- etc

Working with Services

- Services, http://developer.android.com/guide/components/services.html

- An application component that can perform long-running operations in the background and does not provide a user interface
- Examples (Background processing/tasks)
  - Handle network transactions
  - Play music
  - Perform file I/O
  - Interact with content provider
- Launching two forms of services
  - Started:
    - A service is "started" when an application component (such as an activity) starts it by calling **startService()** method, http://developer.android.com/reference/android/content/Context.html#startService(android.content.Intent)
  - Bound:
    - A service is "bound" when an application component binds to it by calling **bindService()**
- Other Examples of service implementations
  - Routinely check updates: weather, email, or social network app
  - A photo or Media app that keeps its data in SYNC online (package and upload new content in the background when the service is idle)
  - A video-editing app might offload heavy processing to a queue on its service (to avoid affecting overall system performance for non-essential tasks)

Android Programming Exercises

- **1st Programming Exercise**, Hello World, http://developer.android.com/training/basics/firstapp/index.html
- **2nd Programming Exercise**, an Activity (a single screen with a text field and a button), http://developer.android.com/training/basics/firstapp/building-ui.html
- **3rd Programming Exercise,** Starting Another Activity, http://developer.android.com/training/basics/firstapp/starting-activity.html
- **4th Programming Exercise,** Managing the Activity Lifecycle, (download the activity demo), http://developer.android.com/training/basics/activity-lifecycle/index.html
  - Starting an Activity, http://developer.android.com/training/basics/activity-lifecycle/starting.html
  - Pausing and Resuming an Activity, http://developer.android.com/training/basics/activity-lifecycle/pausing.html
  - Stopping and Restarting an Activity, http://developer.android.com/training/basics/activity-lifecycle/stopping.html
  - Recreating an Activity, http://developer.android.com/training/basics/activity-lifecycle/recreating.html

References

[1] Android documentation references, http://developer.android.com/index.html

[2] Lauren Darcey and Shane Conder, Android Wireless Application Development, 2nd Edition, Addison Wesley, 2011

[3] Reto Meier, Professional Android 4 Application Development, 2012, John Wiley & Sons, Inc