Android Common Services & Apps (Part 2):
Service Frameworks & Packaged Apps

Douglas C. Schmidt
d.schmidt@vanderbilt.edu
www.dre.vanderbilt.edu/~schmidt

Institute for Software Integrated Systems
Vanderbilt University
Nashville, Tennessee, USA
Learning Objectives in this Part of the Lesson

1. Name & recognize common services in the Android Application Framework layer

- DownloadManager Service
- NotificationManager Service
- WindowManager Service
- LocationManager Service
- TelephonyManager Service
- Activity Manager Service
- PackageManager Service
- WindowManager Service
- Service Manager
- Zygote
- Init
Learning Objectives in this Part of the Lesson

1. Name & recognize common services in the Android Application Framework layer

You’ll use these services extensively when developing & running Android apps!
Learning Objectives in this Part of the Lesson

1. Name & recognize common services in the Android Application Framework layer
2. Name & recognize common apps that are available on an Android device

You probably use these (& other) Android apps every day!
Overview of the Android Application Framework
Overview of Android: Application Framework Layer

- Android's Application framework layer contains system services that provide apps with capabilities & info they need to do their work.

See anatomyofandroid.com/2013/10/03/system-services
Overview of Android: Application Framework Layer

- Android's **Application framework** layer contains system services that provide apps with capabilities & info they need to do their work.
  - Expose hardware & Linux OS kernel capabilities to apps
  - Run continuously during system operation
  - Control flow is driven by various events & callbacks
Overview of Android: Application Framework Layer

- Android's Application framework layer contains system services that provide apps with capabilities & info they need to do their work.
- Expose hardware & Linux OS kernel capabilities to apps.
- Run continuously during system operation.
- Control flow is driven by various events & callbacks.
Overview of Android: Application Framework Layer

- Android’s Application framework layer contains system services that provide apps with capabilities and information they need to do their work.
- Expose hardware & Linux OS kernel capabilities to apps.
- Run continuously during system operation.
- Control flow is driven by various events & callbacks.

The diagram illustrates the components of Android, including:

- **Applications**: Home, Dialer, SMS/MMS, IM, Browser, Camera, Alarm, Calculator, Contacts, Voice Dial, Email, Calendar, Media Player, Photo Album, Clock.
- **Application Framework**: Activity Manager, Window Manager, Content Providers, View System, Notification Manager, Package Manager, Telephony Manager, Resource Manager, Location Manager.
- **Libraries**: Surface Manager, Media Framework, SQLite, WebKit, Libc, OpenGL ES, Audio Manager, FreeType, SSL, Core Libraries.
- **Android Runtime**: ART, Dalvik Virtual Machine.
Overview of Android: Application Framework Layer

• Android’s Application framework layer contains system services that provide apps w/capabilities & info they need to do their work.

These system services are largely written in Java, with some C/C++ native code.
Overview of Android: Application Framework Layer

• Developers can access Android’s system services via the method `getSystemService()` available in an activity or any other context.

```
public abstract Object getSystemService(String name)
```

Added in API level 1

Return the handle to a system-level service by name. The class of the returned object varies by the requested name. Currently available names are:

- `WINDOW_SERVICE` ("window")
  The top-level window manager in which you can place custom windows. The returned object is a `WindowManager`.

- `ACTIVITY_SERVICE` ("activity")
  A `ActivityManager` for interacting with the global activity state of the system.

- `NOTIFICATION_SERVICE` ("notification")
  A `NotificationManager` for informing the user of background events.

- `LOCATION_SERVICE` ("location")
  A `LocationManager` for controlling location (e.g., GPS) updates.

- `DOWNLOAD_SERVICE` ("download")
  A `DownloadManager` for requesting HTTP downloads.

See developer.android.com/reference/android/content/Context.html#getSystemService
Overview of Android: Application Framework Layer

• Developers can reuse the system services in Android’s application framework layer to program powerful apps effectively & productively

See sites.google.com/site/io/inside-the-android-application-framework
Overview of Android: Application Framework Layer

- Developers can reuse the system services in Android’s application framework layer to program powerful apps effectively & productively, e.g.
- Leverage time-proven patterns (e.g., Broker & Proxy) & frameworks (e.g., Binder, HaMeR, & AsyncTask)

See www.kircher-schwanninger.de/michael/publications/BrokerRevisited.pdf
Overview of Android: Application Framework Layer

- Developers can reuse the system services in Android’s application framework layer to program powerful apps effectively & productively, e.g.
  - Leverage time-proven patterns (e.g., Broker & Proxy) & frameworks (e.g., Binder, HaMeR, & AsyncTask)
  - Apps (& app developers) don’t need to “reinvent the wheel”
Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager

![Diagram of System Server Process]

A “super server” that ensures system services are started & restarted throughout the lifetime of an Android device

See [anatomyofandroid.com/2013/10/11/service-manager](anatomyofandroid.com/2013/10/11/service-manager)
Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager

![Diagram of System Server Process]

- Automatically started by the “Init” process when the Android Linux kernel boots

See [anatomyofandroid.com/2013/10/11/service-manager](anatomyofandroid.com/2013/10/11/service-manager)
Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager

**System Server Process**

- DownloadManager Service
- NotificationManager Service
- WindowManager Service
- LocationManager Service
- TelephonyManager Service
- PackageManager Service
- WindowManager Service
- Activity Manager Service
- PackageManager Service
- ... Service

It provides a combination of the “Yellow Pages” & “White Pages” directory capabilities for all the system services available on an Android device

Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager
- Activity Manager
  - Controls all components in the system

See developer.android.com/reference/android/app/ActivityManager.html

**We focus on the Activity Manager Service throughout this course**
Android system services are coordinated by the ServiceManager

- Activity Manager
- Download Manager
  - Handles long-running HTTP downloads stored to a particular file

See developer.android.com/reference/android/app/DownloadManager.html
Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager
  - Activity Manager
  - Download Manager
  - Location Manager
    - Provides access to the system location services

See developer.android.com/reference/android/location/LocationManager.html
Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager
  - Activity Manager
  - Download Manager
  - Location Manager
  - Notification Manager
    - Inform user of events that happen in the background

See developer.android.com/reference/android/app/NotificationManager.html
Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager
  - Activity Manager
  - Download Manager
  - Location Manager
  - Notification Manager
  - Package Manager
    - Stores various kinds of info related to app packages currently installed on the device

See developer.android.com/reference/android/content/pm/PackageManager.html
Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager
- Activity Manager
- Download Manager
- Location Manager
- Notification Manager
- Package Manager
- Telephony Manager
  - Provides access to info about telephony services on the device

See developer.android.com/reference/android/telephony/TelephonyManager.html
Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager
  - Activity Manager
  - Download Manager
  - Location Manager
  - Notification Manager
  - Package Manager
  - Telephony Manager
  - Window Manager
    - Provides interface that apps use to talk with window manager

Example System Services in Application Framework Layer

- Android system services are coordinated by the ServiceManager
  - Activity Manager
  - Download Manager
  - Location Manager
  - Notification Manager
  - Package Manager
  - Telephony Manager
  - Window Manager
  - etc.

Overview of Common Android Apps
Overview of Common Android Apps

- On the top of Android’s software stack are apps we use every day.
Overview of Common Android Apps

• On the top of Android’s software stack are apps we use every day, e.g.
  • Browser
    • Retrieves, presents, & traverses info resources on the World Wide Web

See packages/apps/Browser
Overview of Common Android Apps

• On the top of Android’s software stack are apps we use every day, e.g.
  • Browser
  • Email
    • Provides email message composition, reception, & management functions

See packages/apps/Email
Overview of Common Android Apps

On the top of Android’s software stack are apps we use every day, e.g.

- Browser
- Email
- Camera
  - Encodes digital images & videos digitally & stores them for later viewing

See packages/apps/Camera
Overview of Common Android Apps

- On the top of Android’s software stack are apps we use every day, e.g.
  - Browser
  - Email
  - Camera
  - SMS/MMS
    - Send/receive messages with multimedia content to/from mobile phones over a cellular network

See packages/apps/Mms
Overview of Common Android Apps

• On the top of Android’s software stack are apps we use every day, e.g.
  • Browser
  • Email
  • Camera
  • SMS/MMS
  • Calendar
    • Tracks time-based events & appointments

See packages/apps/Calendar
Overview of Common Android Apps

- On the top of Android’s software stack are apps we use every day, e.g.
  - Browser
  - Email
  - Camera
  - SMS/MMS
  - Calendar
  - Contacts

- Facilitate the recording, tracking, & management of certain types of personal information about friends, family, & colleagues

See packages/apps/Contacts
Overview of Common Android Apps

- On the top of Android’s software stack are apps we use every day, e.g.
  - Browser
  - Email
  - Camera
  - SMS/MMS
  - Calendar
  - Contacts
  - Phone
    - Allows user to place & receive phone calls

See packages/apps/Phone
Overview of Common Android Apps

- On the top of Android’s software stack are apps we use every day, e.g.
  - Browser
  - Email
  - Camera
  - SMS/MMS
  - Calendar
  - Contacts
  - Phone
  - Music
    - Select & play audio/music files on a device

See packages/apps/Music
Overview of Common Android Apps

- On the top of Android’s software stack are apps we use every day, e.g.
  - Browser
  - Email
  - Camera
  - SMS/MMS
  - Calendar
  - Contacts
  - Phone
  - Music
  - etc.

<table>
<thead>
<tr>
<th>BasicSmsReceiver</th>
<th>Gallery</th>
<th>PhoneCommon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluetooth</td>
<td>Gallery2</td>
<td>Protips</td>
</tr>
<tr>
<td>Browser</td>
<td>HTMLViewer</td>
<td>Provision</td>
</tr>
<tr>
<td>Calculator</td>
<td>InCallUI</td>
<td>QuickSearchBox</td>
</tr>
<tr>
<td>Calendar</td>
<td>KeyChain</td>
<td>Settings</td>
</tr>
<tr>
<td>Camera</td>
<td>Launcher2</td>
<td>SmartCardService</td>
</tr>
<tr>
<td>Camera2</td>
<td>Launcher3</td>
<td>SoundRecorder</td>
</tr>
<tr>
<td>CellBroadcastReceiver</td>
<td>LegacyCamera</td>
<td>SpareParts</td>
</tr>
<tr>
<td>CertInstaller</td>
<td>ManagedProvisioning</td>
<td>SpeechRecorder</td>
</tr>
<tr>
<td>Contacts</td>
<td>Mms</td>
<td>Stk</td>
</tr>
<tr>
<td>ContactsCommon</td>
<td>Music</td>
<td>Tag</td>
</tr>
<tr>
<td>DeskClock</td>
<td>MusicFX</td>
<td>Terminal</td>
</tr>
<tr>
<td>Dialer</td>
<td>Nfc</td>
<td>TvSettings</td>
</tr>
<tr>
<td>Email</td>
<td>OneTimeInitializer</td>
<td>UnifiedEmail</td>
</tr>
<tr>
<td>Exchange</td>
<td>PackageInstaller</td>
<td>VoiceDialer</td>
</tr>
<tr>
<td>FMRadio</td>
<td>Phone</td>
<td></td>
</tr>
</tbody>
</table>

See packages/apps
Android apps are largely written in Java & many pre-packaged in the Android Open Source Project (AOSP) release.

See [source.android.com/source](http://source.android.com/source)
Overview of Common Android Apps

• Other popular apps are not available in open-source form

See play.google.com/store/apps/dev?id=5700313618786177705
Packaging & Distributing Android Apps

- Apps are packaged into “APK” archives that contain certain files & directories
  - All the app’s code
    - e.g., .dex files
  - Resources
    - e.g., binary versions of the XML code
  - Assets
    - e.g., logos
  - Certificates
    - e.g., for authentication
  - An AndroidManifest
    - e.g., defines all the app components

See en.wikipedia.org/wiki/Android_application_package
Packaging & Distributing Android Apps

- You can distribute your apps via the Google Play Store

See play.google.com/store/apps?hl=en
Packaging & Distributing Android Apps

• You can distribute your apps via the Google Play Store
• Google documents best practices & useful tips to help distribute successful apps on the Google Play Store

See developer.android.com/distribute/googleplay/guide.html
Packaging & Distributing Android Apps

- You can build/distribute apps once you’ve mastered the material we cover!

You’ll use this knowledge extensively when developing & deploying your own apps!
End of Common Services & Apps (Part 2):
Service Frameworks & Packaged Apps