17-708 SOFTWARE PRODUCT LINES: CONCEPTS AND IMPLEMENTATION

ANDROID CASE STUDY

CHRISTIAN KAESTNER
CARNEGIE MELLON UNIVERSITY
INSTITUTE FOR SOFTWARE RESEARCH

READING ASSIGNMENT OCT 7

Antkiewicz, M., Ji, W., Berger, T., Czarnecki, K., Schmorleiz, T., Lämmel, R., et al. (2014, May). Flexible product line engineering with a virtual platform. In Companion Proceedings of the 36th International Conference on Software Engineering (pp. 532-535). ACM.

Artho, C., Suzaki, K., Di Cosmo, R., Treinen, R., & Zacchiroli, S. (2012, June). Why do software packages conflict?. In Proceedings of the 9th IEEE Working Conference on Mining Software Repositories (pp. 141-150). IEEE Press.

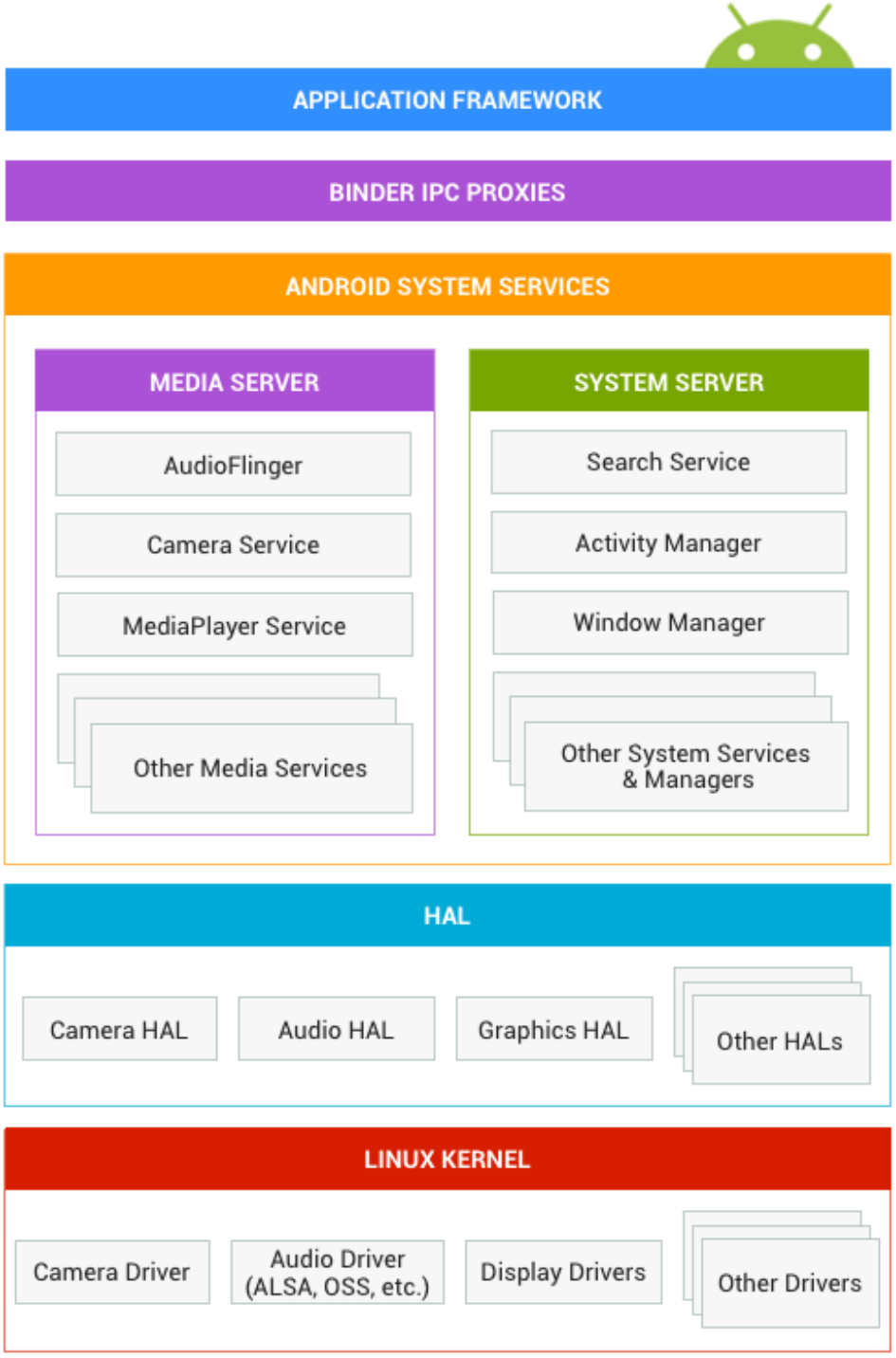
LEARNING GOALS

Understand how and why platform and framework mechanisms were used in Android

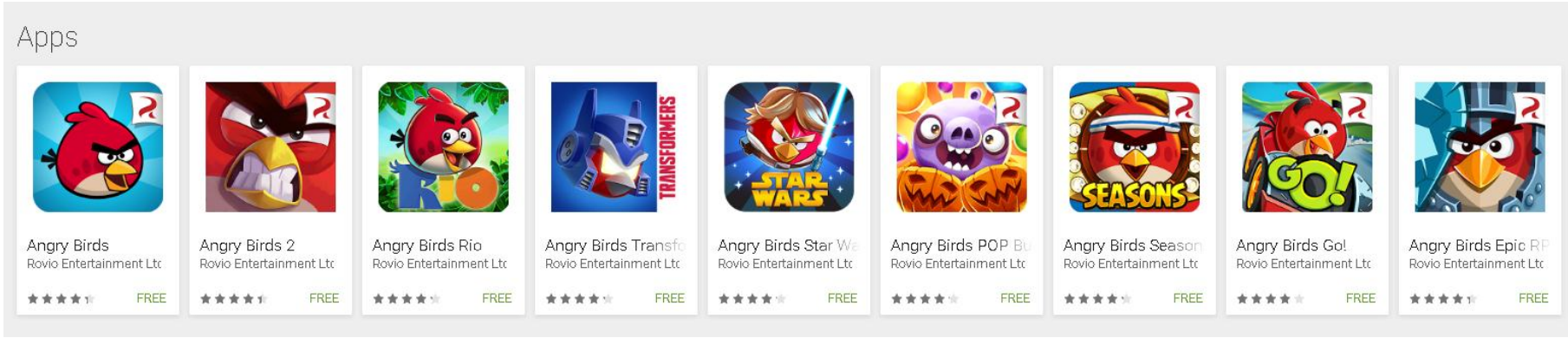
Apply isolation as a strategy to avoid/manage feature interactions

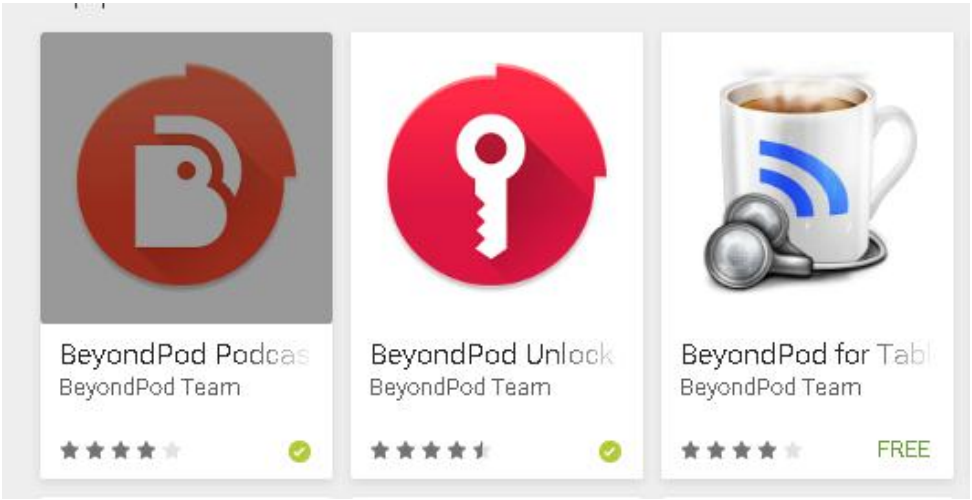
Understand how runtime/compile-time variability is used in Android apps

Understand the granularity and flexibility implications of Android's design decisions

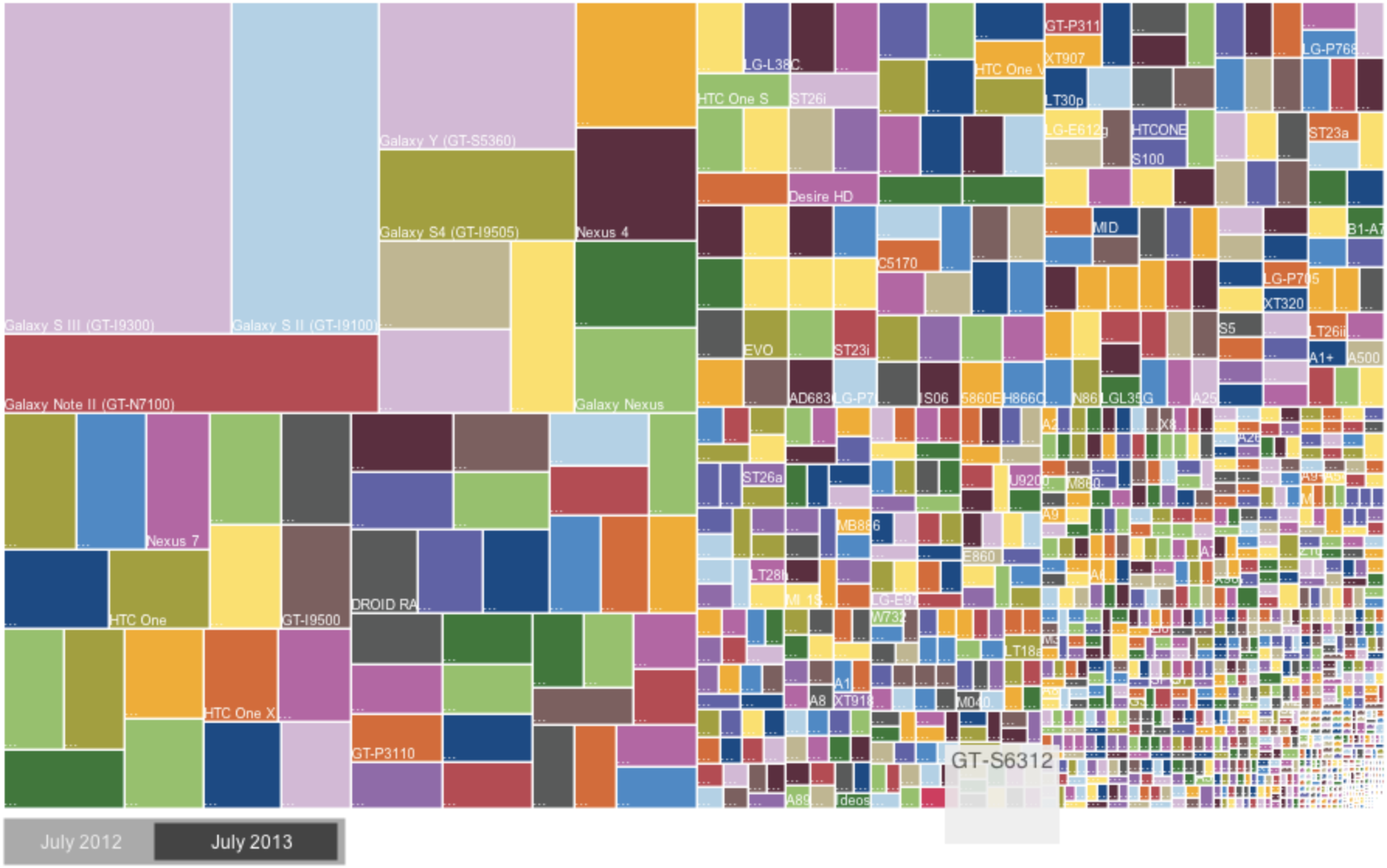

APPLICATION FRAMEWORK
BINDER IPC PROXIES
ANDROID SYSTEM SERVICES
MEDIA SERVER
AudioFlinger
Camera Service
MediaPlayer Service
Other Media Services
SYSTEM SERVER
Search Service
Activity Manager
Window Manager
Other System Services & Managers
HAL
Camera HAL
Audio HAL
Graphics HAL
Other HALs
LINUX KERNEL
Camera Driver
Audio Driver (ALSA, OSS, etc.)
Display Drivers
Other Drivers

VARIATION


Apps
Angry Birds
Rovio Entertainment Ltc
FREE
Angry Birds 2
Rovio Entertainment Ltc
FREE
Angry Birds Rio
Rovio Entertainment Ltc
FREE
Angry Birds Transfo
Rovio Entertainment Ltc
FREE
Angry Birds Star We
Rovio Entertainment Ltc
FREE
Angry Birds POP Bu
Rovio Entertainment Ltc
FREE
Angry Birds Season
Rovio Entertainment Ltc
FREE
Angry Birds Go!
Rovio Entertainment Ltc
FREE
Angry Birds Epic RP
Rovio Entertainment Ltc
FREE


BeyondPod Podcas
BeyondPod Team
BeyondPod Unlock
BeyondPod Team
BeyondPod for Tabl
BeyondPod Team
FREE

DEVICE FRAGMENTATION



techcrunch.com



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Version	Codename	API	Dist.	Release Date
1.0	None	1	*	Sep 23, 2008
1.1	None	2	*	Feb 9, 2009
1.5	Cupcake	3	*	Apr 30, 2009
1.6	Donut	4	0.2%	Sep 15, 2009
2.0	Eclair	5	*	Oct 26, 2009
2.0.1	Eclair	6	*	Dec 3, 2009
2.1	Eclair	7	8.1%	Jan 12, 2010
2.2	Froyo	8	8.1%	May 20, 2010
2.3-2.3.2	Gingerbread	9	0.2%	Dec 6, 2010
2.3.3-2.3.7	Gingerbread	10	45.4%	Feb 9, 2011
3.0	Honeycomb	11	*	Feb 22, 2011
3.1	Honeycomb	12	0.3%	May 10, 2011
3.2	Honeycomb	13	1.0%	Jul 15, 2011
4.0-4.0.2	Honeycomb	14	*	Oct 19, 2011
4.0.3-4.0.4	Ice Cream Sandwich	15	29.0%	Dec 16, 2011
4.1	Jelly Bean	16	12.2%	Jul 9, 2012
4.2	Jelly Bean	17	1.4%	Nov 13, 2012

McDonnell et al. An Empirical Study of API Stability and Adoption in the Android Ecosystem. ICSM'13

API Changes in Android Per Version and Evolution Rates

API Version	Release Date	Class Δ	Methods Δ	Methods +	Methods -	Fields Δ	Fields +	Fields -
3	Apr 30, 2009	246	368	60	0	296	68	0
4	Sep 15, 2009	128	70	41	1	208	27	0
5	Oct 26, 2009	187	199	64	0	234	205	0
6	Dec 3, 2009	37	0	2	0	7	1	0
7	Jan 12, 2010	61	52	2	0	22	3	0
8	May 20, 2010	191	200	38	1	195	23	0
9	Dec 6, 2010	244	348	42	9	141	11	0
10	Feb 9, 2011	46	7	0	0	10	0	0
11	Feb 22, 2011	263	416	95	7	619	36	0
12	May 10, 2011	118	73	27	1	87	9	0
13	Jul 15, 2011	69	22	11	0	68	1	0
14	Oct 19, 2011	269	271	98	8	405	34	0
15	Dec 16, 2011	84	25	3	0	38	2	0
Min		37	0	0	0	7	0	0
Max		269	416	98	9	619	205	0
Mean		149	158	37	2	179	32	0
Rate (Total update/month)		**42**	**44**	**11**	**<1**	**51**	**9**	**0**

McDonnell et al. An Empirical Study of API Stability and Adoption in the Android Ecosystem. ICSM'13

API Change Distribution Per Taxon (Feature)

Taxon	Total Updated Versions	Total Updated APIs	Avg. Changes Per API Release	Avg Update Interval (Month)
animation	7	37	5	5.4
appwidget	3	12	4	12.7
bluetooth	5	9	2	7.6
content	10	179	18	3.8
database	6	100	17	6.3
gest	1	3	3	38.0
graphics	10	84	8	3.8
hardware	10	121	12	3.8
io	2	18	9	19.0
location	4	38	10	9.5
media	8	93	12	4.8
net	8	87	11	4.8
opengl	5	10	2	7.6
os	11	94	9	3.5
rtp	0	0	0	
security	2	25	13	19.0
sip	1	2	2	38.0
support	0	0	0	
telephony	5	49	10	7.6
test	8	70	9	4.8
text	9	147	16	4.2
util	6	180	30	6.3
view	12	546	46	3.2
webkit	10	172	17	3.8
wifi	4	14	4	9.5

McDonnell et al. An Empirical Study of API Stability and Adoption in the Android Ecosystem. ICSM'13

```
class ProxyService {
    static boolean NATIVE_PROXY_SUPPORTED
                        = Build.VERSION.SDK_INT >= 12;
    public void onSharedPreferenceChanged() {
        if (!NATIVE_PROXY_SUPPORTED) {
            if (Context.getSystemService("bluetooth")) {
                ...
            }
        }
    }
```

```
01 class ProxyService {
02   static boolean NATIVE_PROXY_SUPPORTED
03                        = Build.VERSION.SDK_INT >= 12;
04   public void onSharedPreferenceChanged() {
05     String ketHost;
06     if (!NATIVE_PROXY_SUPPORTED) {
SDK<12 07       ketHost = getString(R.string.pref_proxyhost);
08       ...
09     }
10     String command = path + " -host ";
11     String result = RootTools.sendShell(command + ketHost);
12     ...
13   }
14 }
15 class ConfigurationActivity {
16   public void onHelp(View view) {
17     Intent intent;
18     if (ProxyService.NATIVE_PROXY_SUPPORTED)
SDK>=12 19       intent = new Intent(this, ProxyConf...);
20     else
SDK<12 21       intent = new Intent(Intent.ACTION_VIEW, uri);
22     startActivity(intent);
23   }
24 }
```

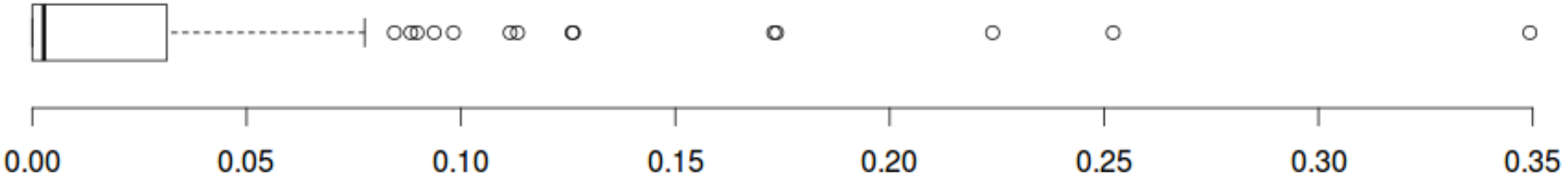
[Lillack, ASE 2014]

`android.os.Build$VERSION:int SDK_INT`	SDK
`Configuration.locale`	LOCALE
`Environment.getExternalStorageState()`	STORAGE
`Context.getSystemService("vibrator")`	VIBRATOR
`Context.getSystemService("bluetooth")`	BLUETOOTH

Option	Apps using option
SDK	38 %
NETWORK	16 %
STORAGE	12 %
BLUETOOTH	7 %
AUDIO	6 %

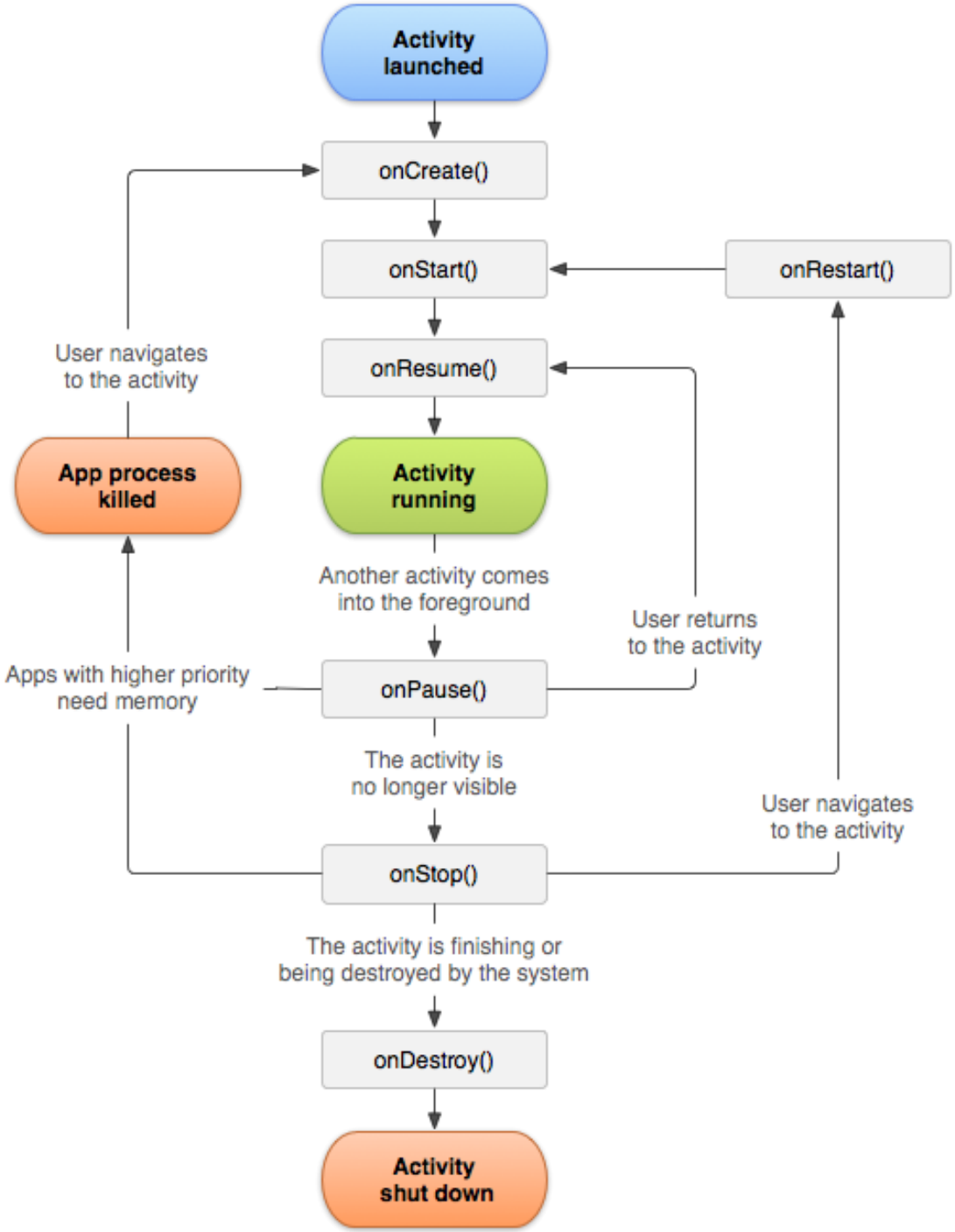
Constraints	Frequency
SDK	34 %
NETWORK	29 %
STORAGE & SDK	11 %
WIFI	5 %
LOCALE	5 %

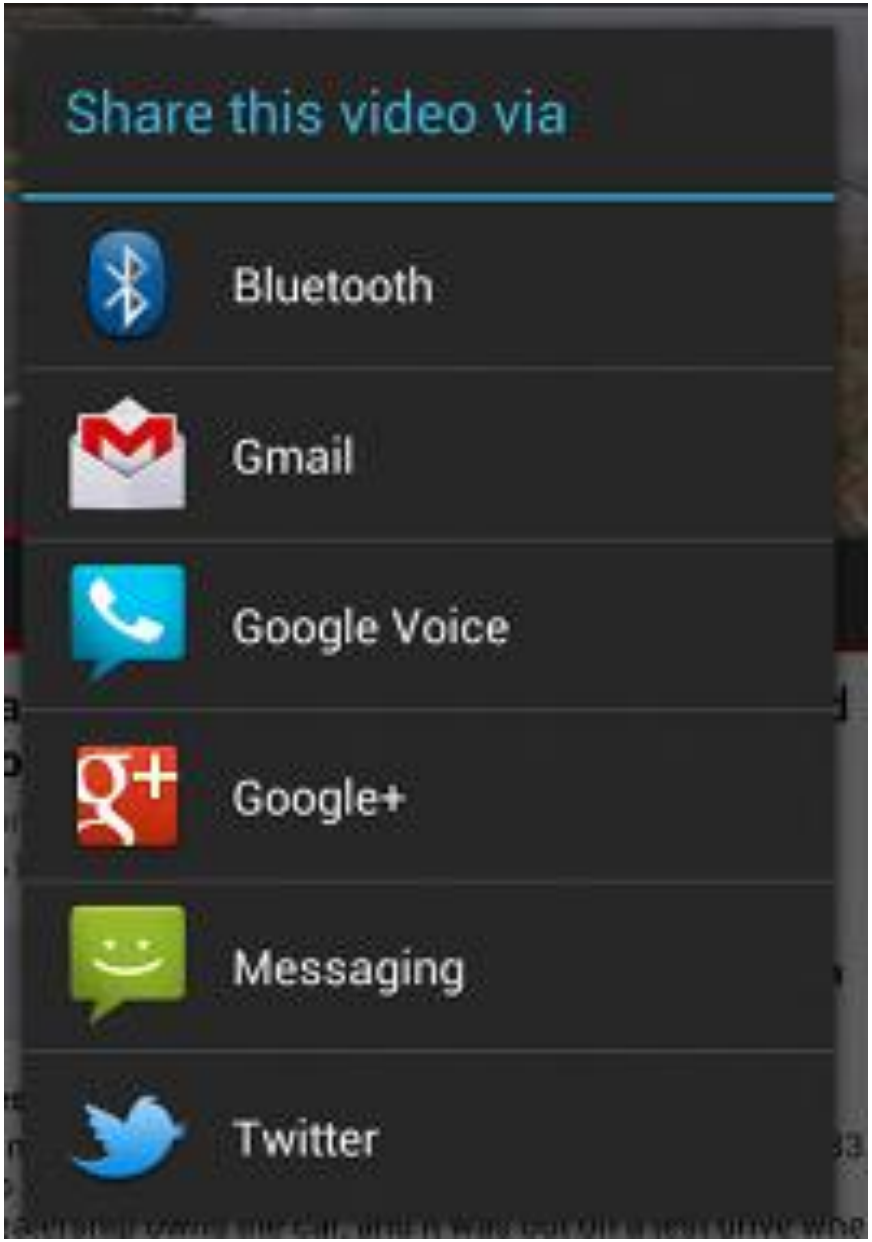
Option-specific code

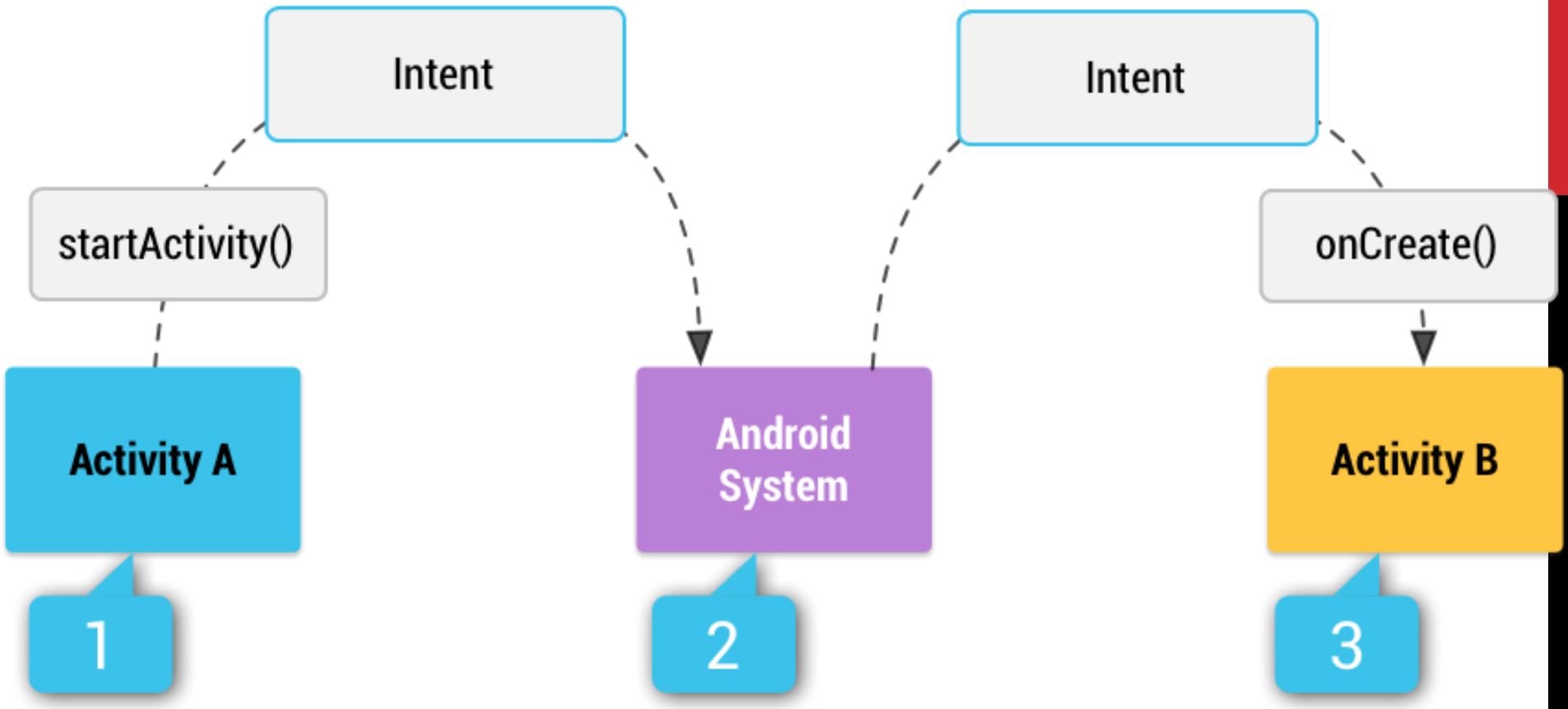


[Lillack, ASE 2014]

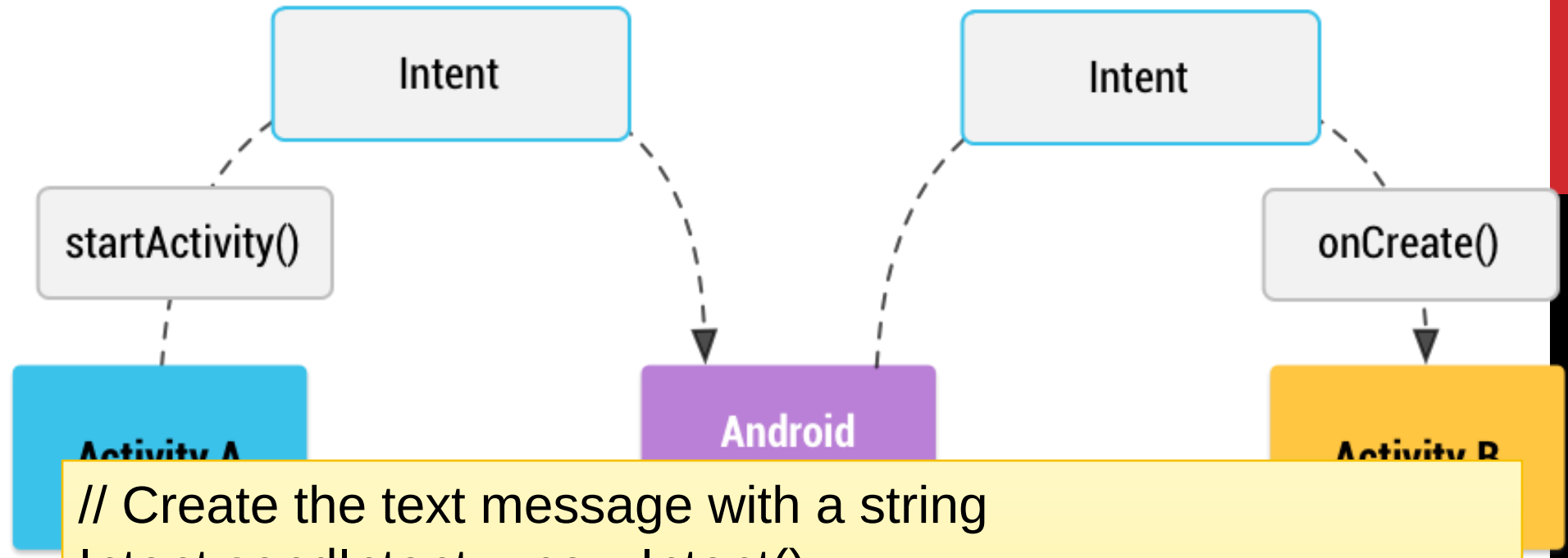
ISOLATION/ INTERACTION


Activity launched
onCreate()
onStart()
onRestart()
onResume()
User navigates to the activity
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


Share this video via
Bluetooth
Gmail
Google Voice
Google+
Messaging
Twitter

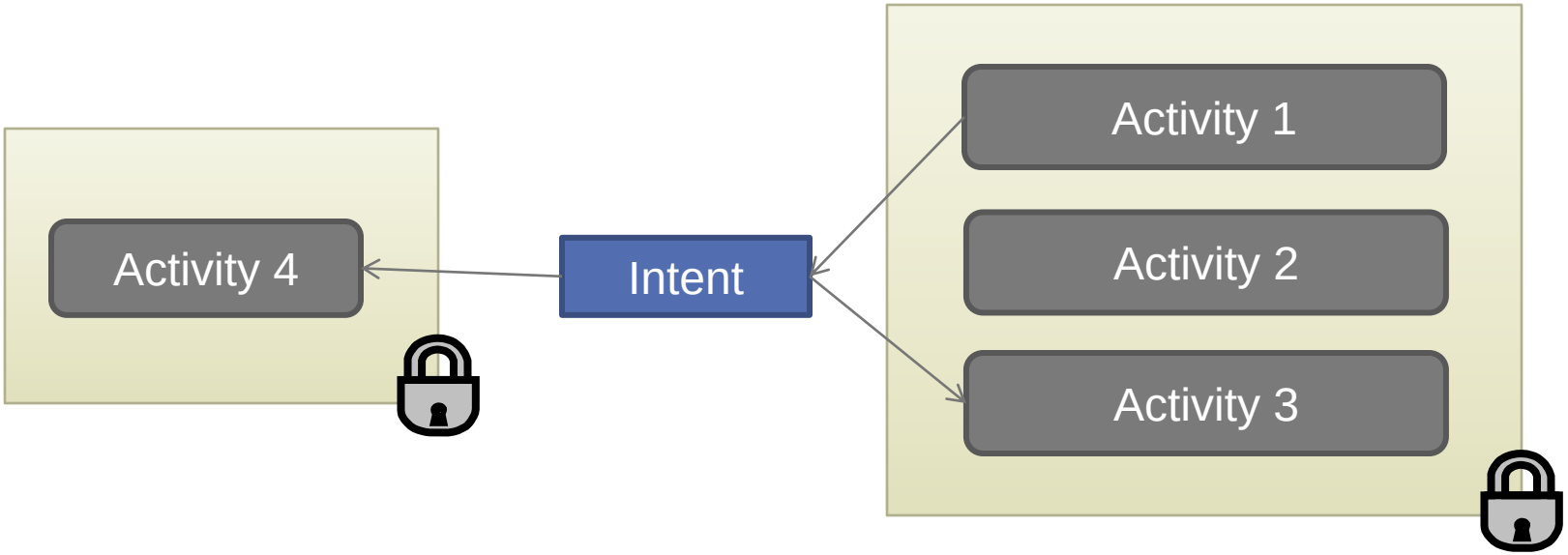



```
Intent downloadIntent = new Intent(this, DownloadService.class);
downloadIntent.setData(Uri.parse(fileUrl));
startService(downloadIntent);
```

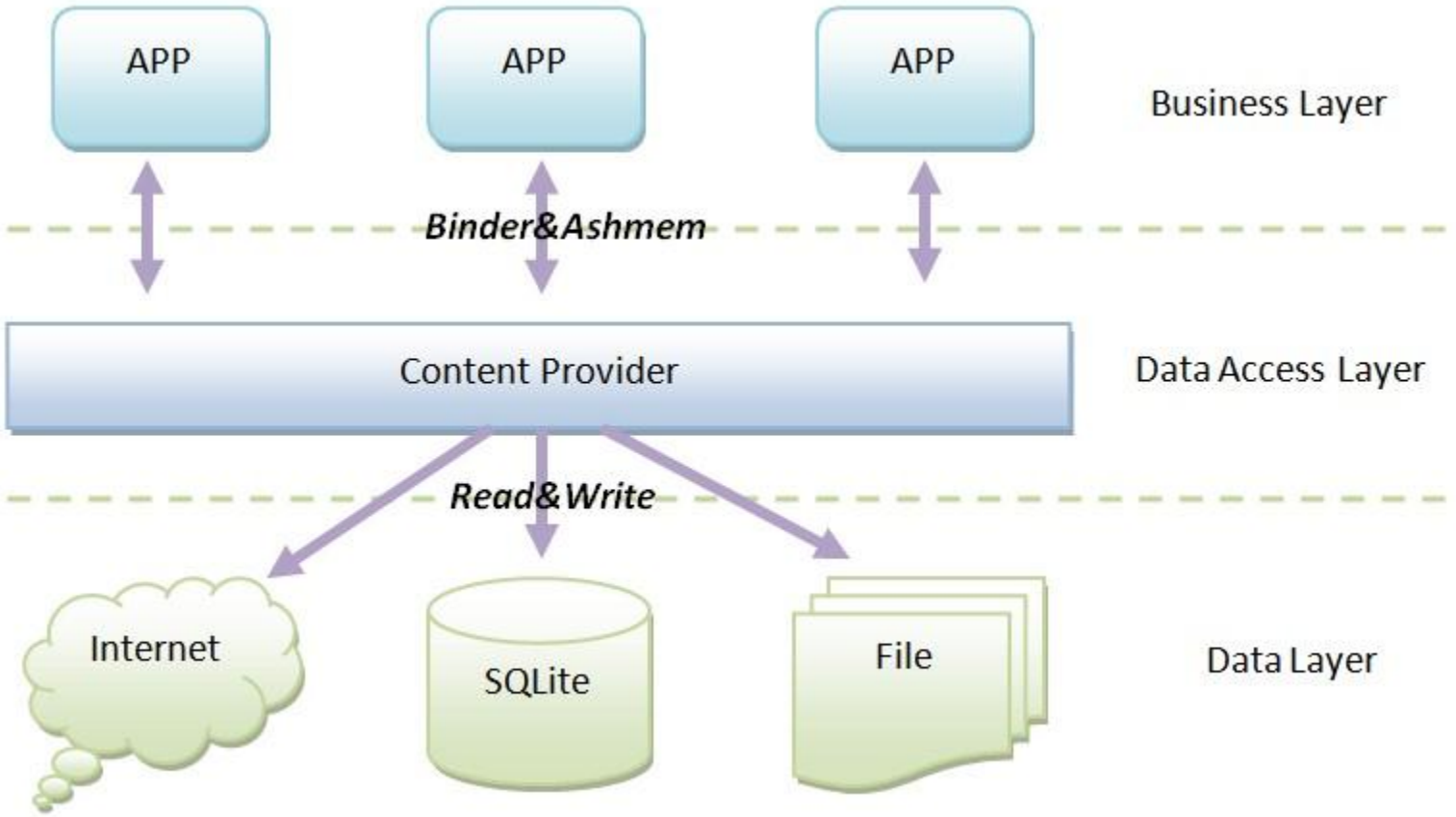



```
// Create the text message with a string
Intent sendIntent = new Intent();
sendIntent.setAction(Intent.ACTION_SEND);
sendIntent.putExtra(Intent.EXTRA_TEXT, textMessage);
sendIntent.setType("text/plain");

// Verify that the intent will resolve to an activity
if (sendIntent.resolveActivity(getPackageManager()) != null) {
    startActivity(sendIntent);
}
```



Security Concerns



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