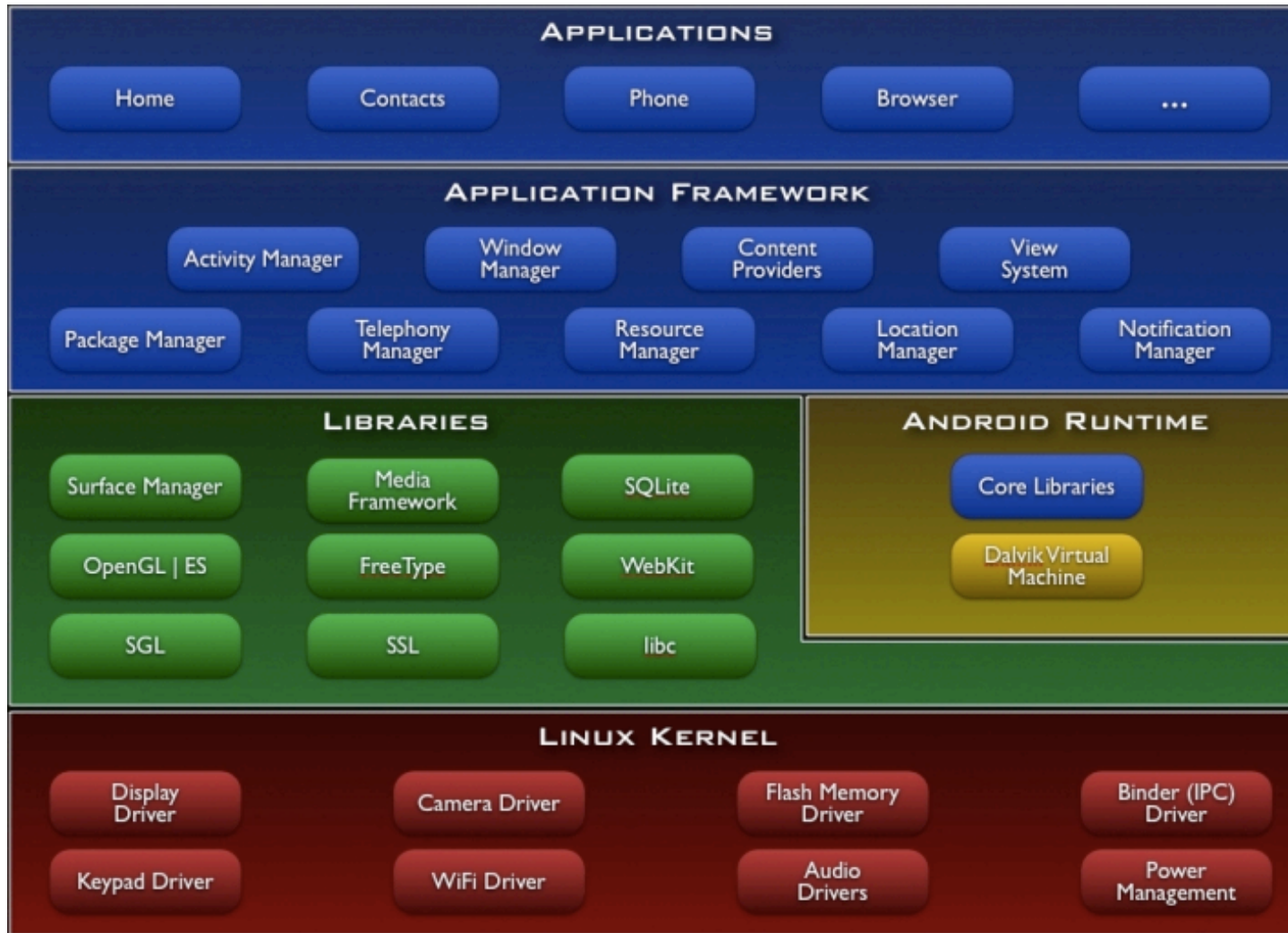


Android Applications



Java

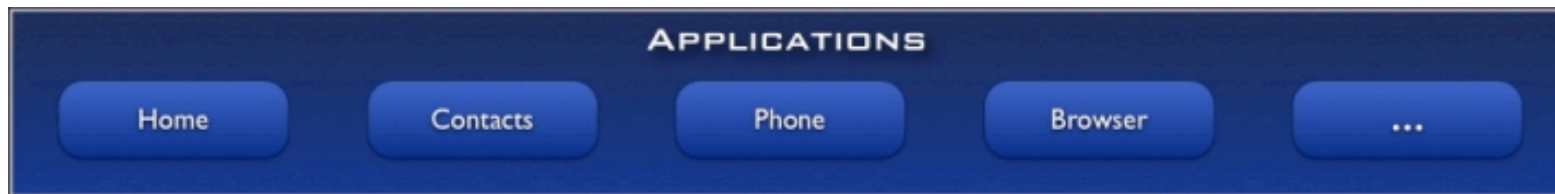
Dalvik

Native

OS

(Android Anatomy and Physiology, Patrick Brady)

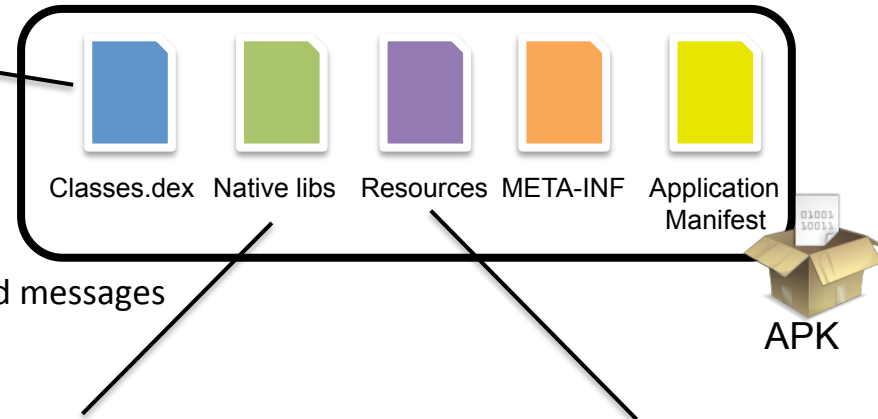
- Third party applications
 - e.g., from Google Play, Amazon Store
- A number of core (“system”) applications (cannot be uninstalled)
 - Contacts, Settings, Browser, Phone, ...
 - Special flag in the package manager to mark them as system application
 - Implement bulk of the application framework API
 - Contacts management, initiating phone calls, SMS/MMS management,...



- APK is simply a packaging format like **JAR**, ZIP, or TAR

- **Components of applications**

- Activity: User interface
- Service: Background service
- Content Provider: SQL-like database
- Broadcast receiver: Mailbox for broadcasted messages



- Applications can contain **native code (C/C++ shared libraries)** and **resources** (e.g., images)

- Native code provided as shared library files that can be dynamically linked into the process
- Resources and assets: String values, layout definitions, drawables (pictures), raw data

- **META-INF** contains the application certificate and package manifest

- Package manifest not to be mistaken with the **application manifest** !

- Declares application meta-data and all components
 - Names, filters, permissions, ...
- Very basic example:

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.example.android.app"
  android:versionCode="1" android:versionName="1.0" >
  <uses-sdk android:minSdkVersion="18" android:targetSdkVersion="18" />
  <application
    android:icon="@drawable/ic_launcher"
    android:label="@string/app_name">
    <activity android:name="com.example.android.app.MainActivity" android:label="@string/app_name">
      <intent-filter>
        <action android:name="android.intent.action.MAIN" />
        <category android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
    </activity>
    <receiver android:name=".MyReceiver" >
      <intent-filter>
        <action android:name="android.intent.action.BOOT_COMPLETED" />
      </intent-filter>
    </receiver>
    ...
  </application>
</manifest>
```

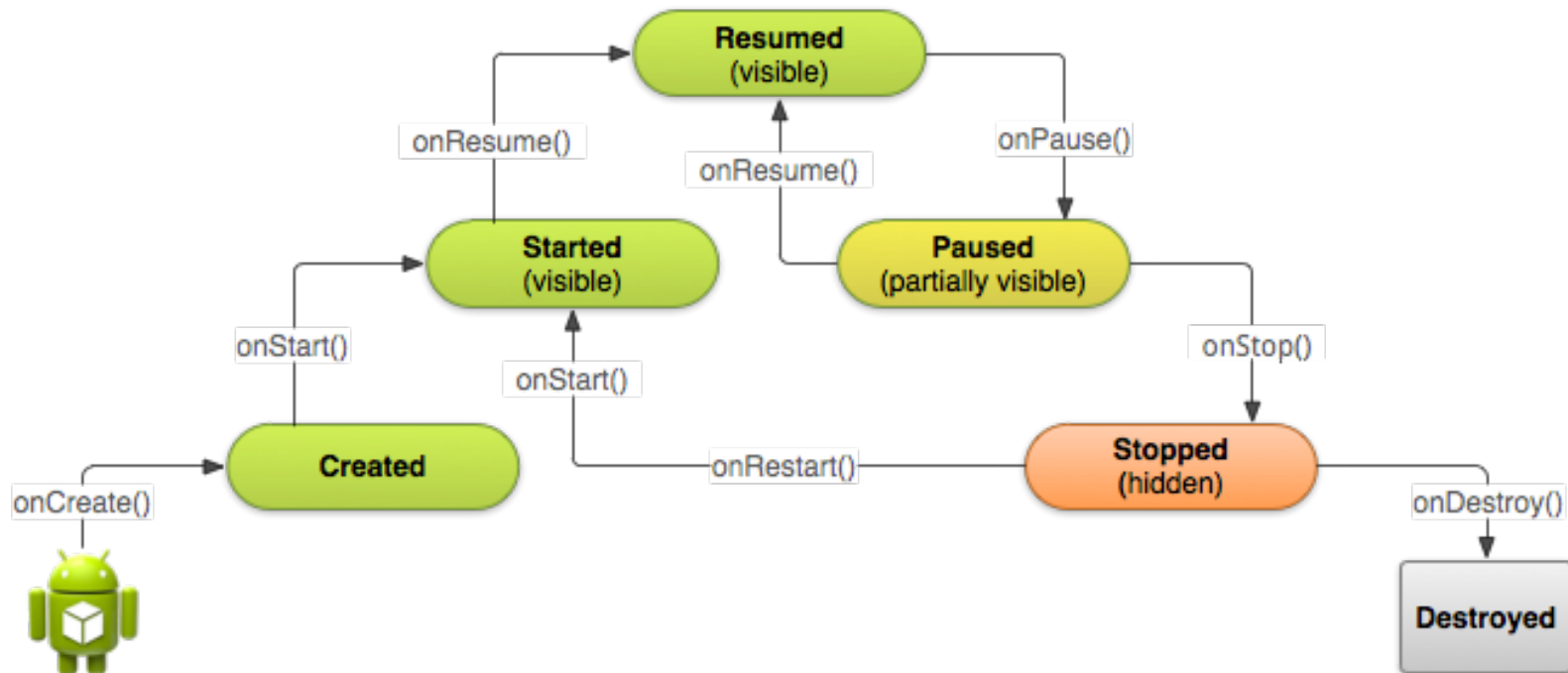
Package info (Package name, Version)

App info (Launcher icon, etc.)

Activity component

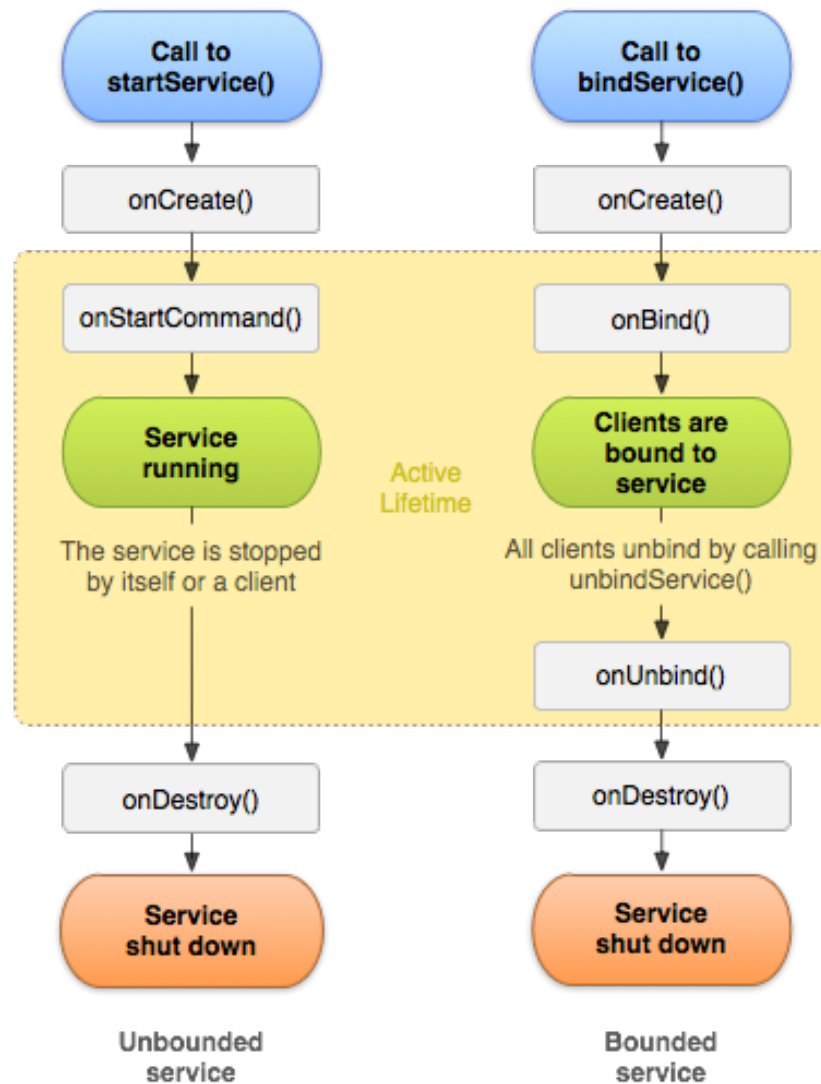
BroadcastReceiver component

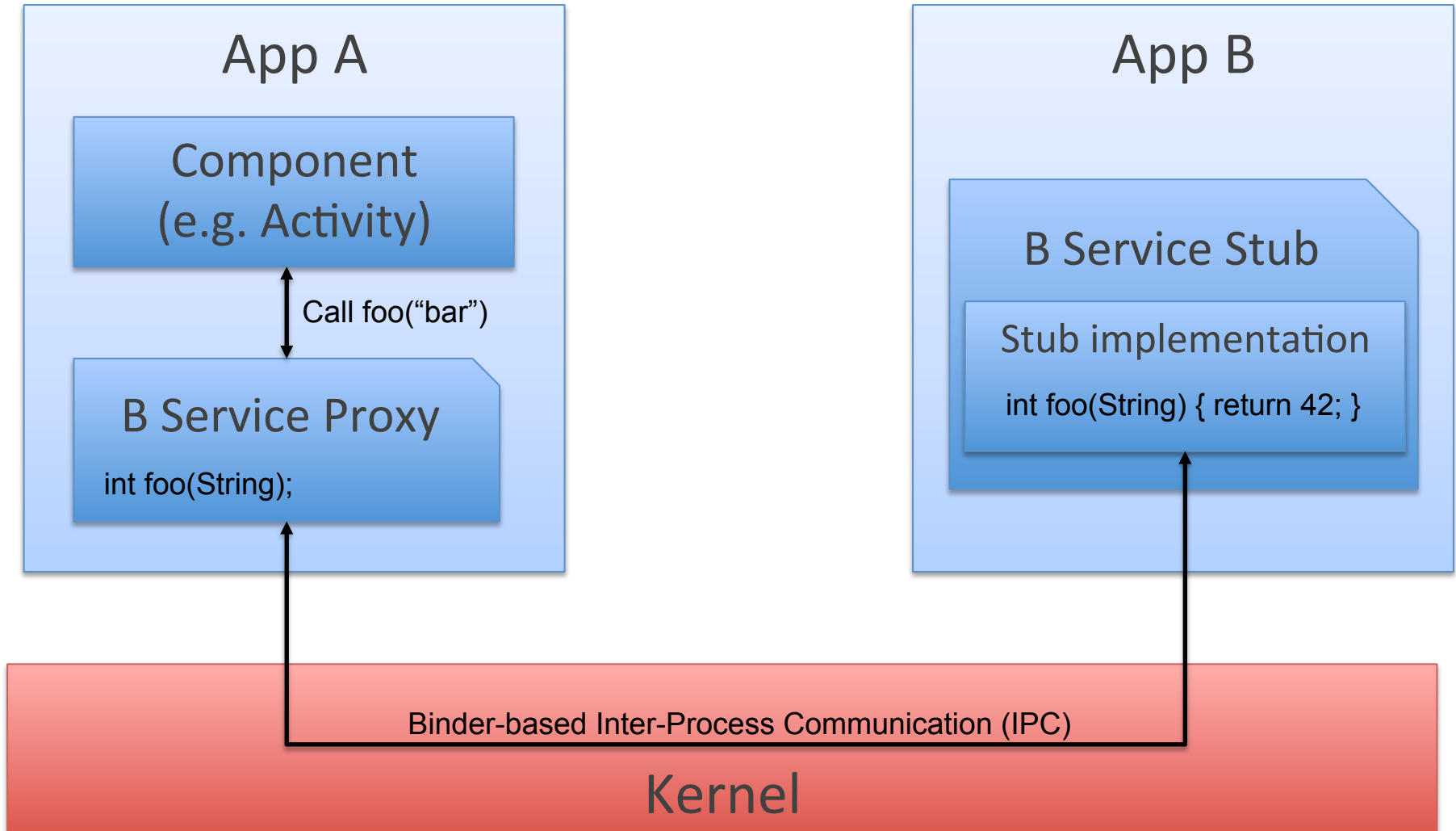
- Represents a single screen in your application
 - Composed of different *Views* (Buttons, lists, text,...)
 - Can be split into different *Fragments*
- Activity lifecycle:



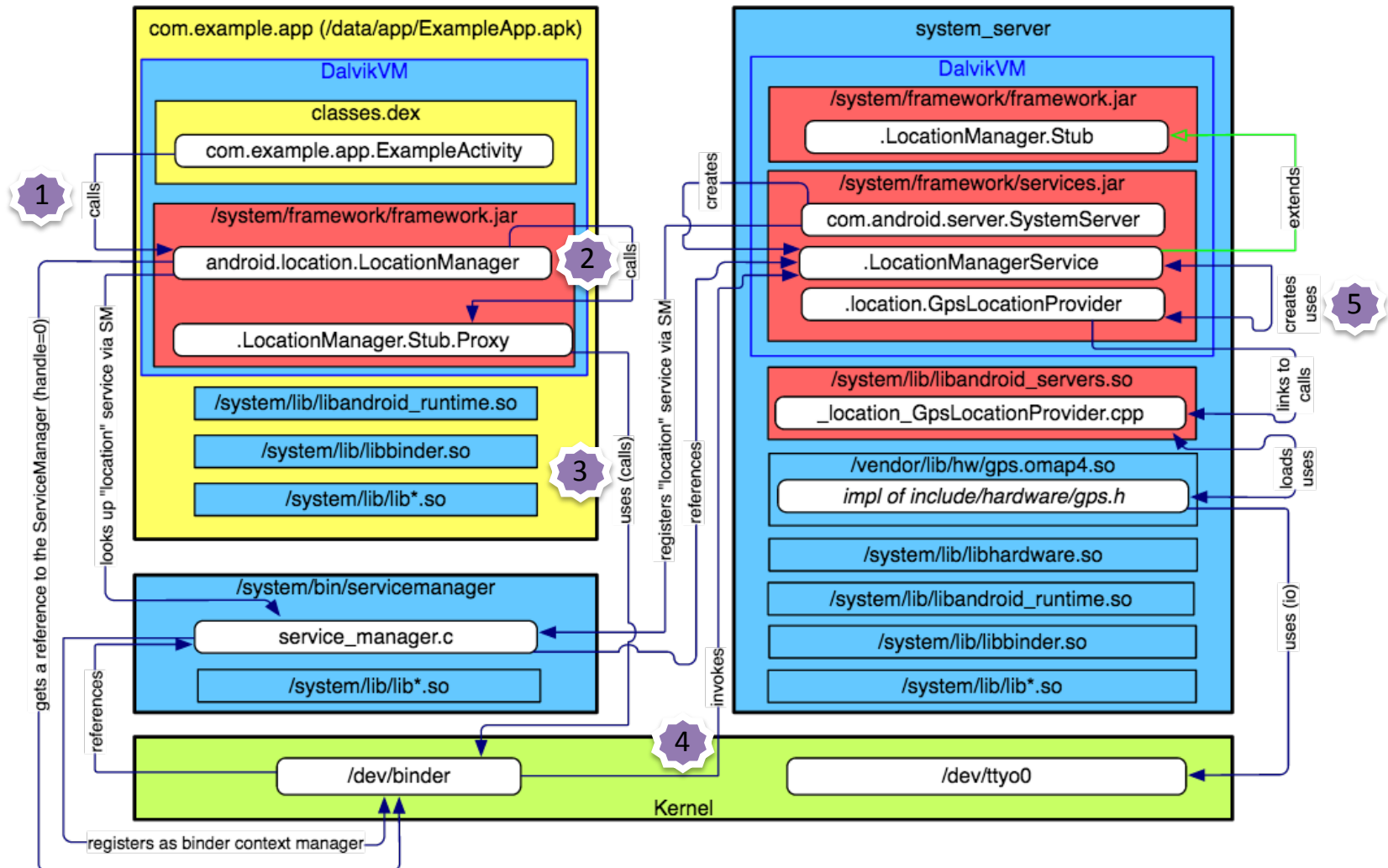
- Data object that represents the *intent* to do something
 - Launching an Activity, starting a Service, broadcast a message, ...
 - Payload and attributes describe the intended action
 - Can be sent and received by an application
 - Transmitted between applications via Binder-based IPC
- Receiver can be described explicit or implicit
 - Explicit: Set target component name
 - “com.example.app.MainActivity”
 - Implicit: Set an Action string, Category, and Data; the Android framework will find a suitable receiver for this Intent
 - Action = Intent.ACTION_VIEW ; Data=“http://www.google.com” will open app that can show the website, e.g., the default browser app

- Background processes without user interaction
 - Potentially long running
 - E.g. polling emails from a webserver
- Can be local to the app or remote (provided by another app)
 - Remote: Interface can be defined in domain-specific language *Android Interface Definition Language (AIDL)*
 - AIDL compiler creates skeleton for implementation of service (*stub*) and a *proxy* object abstracting the service and encapsulating
 - Common approach to implement the Android application framework API (Location manager, Wi-Fi manager, etc.)
- Can be *started* by a client or be *bound* by one or more clients





Location on Android



Source: https://thenewcircle.com/s/post/1340/Deep_Dive_Into_Binder_Presentation.htm#slide-11

- Standardized mechanism to share data among applications
 - Contacts data, SMS data, media metadata,...
- SQLite-like data management
 - Insert, Delete, Update, Query
- URIs to address ContentProviders and their data:

`content://com.android.book.BookProvider/book/23`

Diagram illustrating the components of the URI `content://com.android.book.BookProvider/book/23`:

- Scheme:** `content`
- Authority name:** `com.android.book.BookProvider`
- Path Segments:** `/book/23`

`com.android.book.BookProvider`

Table: book

id	Title	Author ID
1	Embedded Android	1
23	Pro Android 4	42

Table: author

id	Name
1	K. Yaghmour
42	S. Komatinie & D. MacLean

- Mailbox for broadcast Intent messages
 - Define filters which kind of messages to receive
 - Action string, category,...
- Registered in the application manifest or dynamically at runtime
- Very short-lived, bound to processing the Intent
 - Kick-off longer-lived workloads to Activities or Services
- Common operations to listen to with a BroadcastReceiver
 - Location changes
 - User presence (unlocking the screen)
 - Finished booting of the device (“auto start” of app)
 - SMS/MMS received

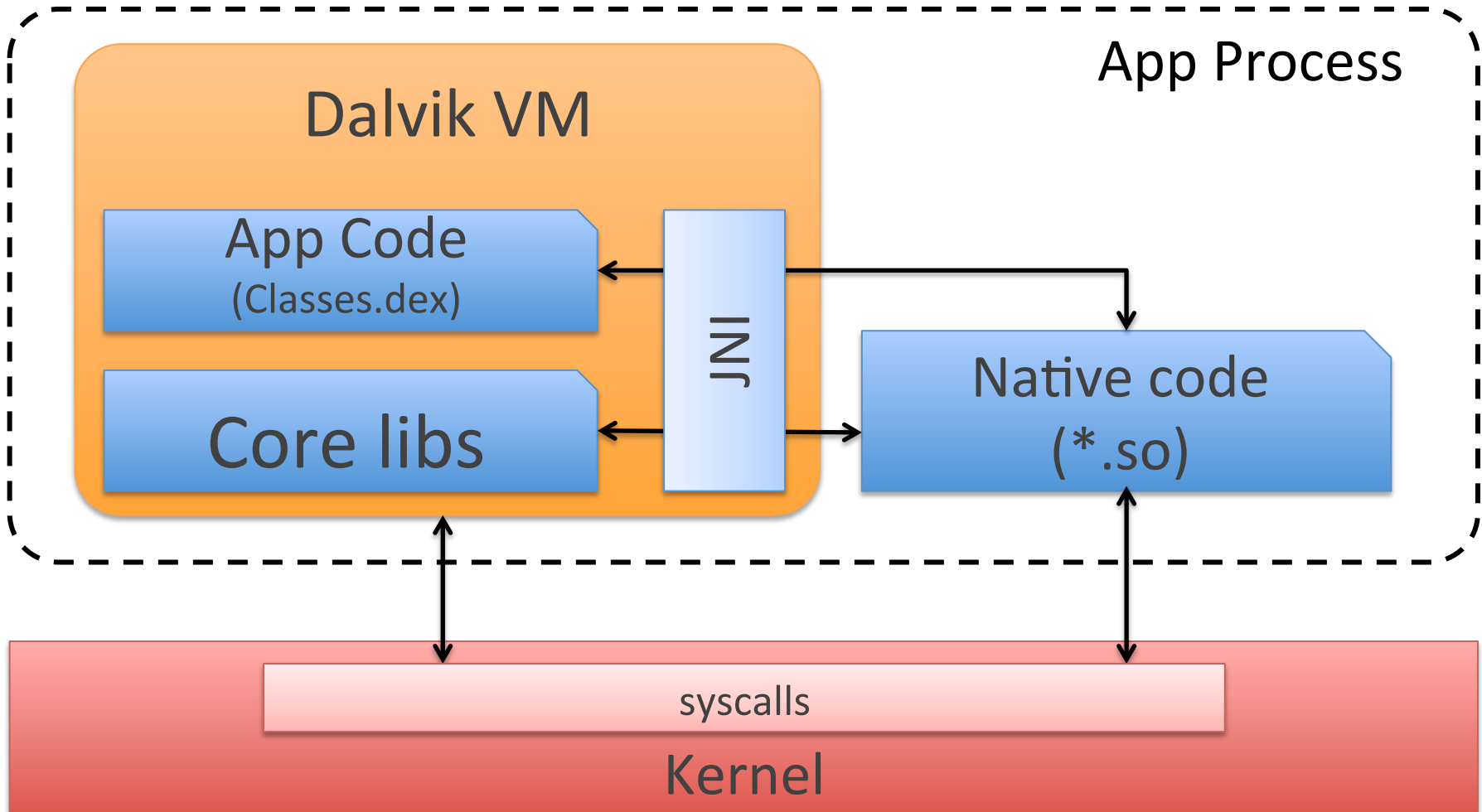
■ Dalvik Virtual Machine

- VM optimized for embedded environments
- Runs optimized file format “.dex” and Dalvik bytecode generated from Java .class/.jar files at build time
- Relies on underlying Linux kernel for threading and low-level memory management

■ Core Libraries

- Provide most of the functionality available in the core libraries of Java
- Provides core APIs of Java (familiar programming environment)





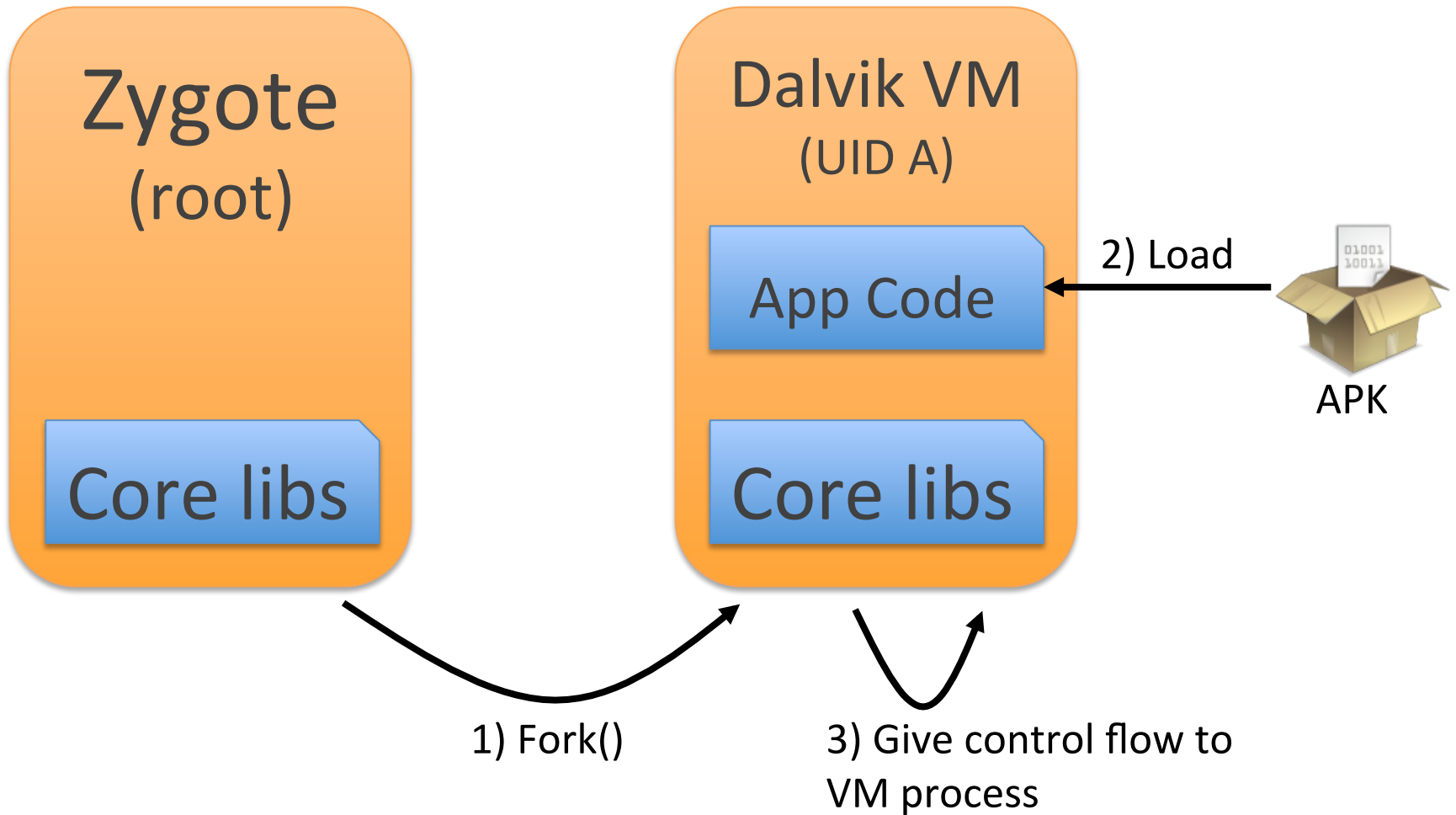
JNI = Java Native Interface

PROCESS TREE ON LINUX

PID	USER	PRI	NI	VIRT	RES	SHR	S	CPU%	MEM%	TIME+	Command
211	bernd	20	0	7564	1108	0	S	0.0	0.2	0:00.00	(sd-pam)
168	root	20	0	7164	1552	1136	S	0.0	0.3	0:00.04	/usr/bin/sshd -D
154	polkitd	20	0	72012	4688	696	S	0.0	0.9	0:00.17	/usr/lib/polkit-1/polkitd --no-debug
162	polkitd	20	0	72012	4688	696	S	0.0	0.9	0:00.00	/usr/lib/polkit-1/polkitd --no-debug
160	polkitd	20	0	72012	4688	696	S	0.0	0.9	0:00.00	/usr/lib/polkit-1/polkitd --no-debug
159	polkitd	20	0	72012	4688	696	S	0.0	0.9	0:00.00	/usr/lib/polkit-1/polkitd --no-debug
158	polkitd	20	0	72012	4688	696	S	0.0	0.9	0:00.04	/usr/lib/polkit-1/polkitd --no-debug
157	polkitd	20	0	72012	4688	696	S	0.0	0.9	0:00.00	/usr/lib/polkit-1/polkitd --no-debug
148	root	20	0	15472	2152	604	S	0.0	0.4	0:00.14	/usr/bin/slim -nodaemon
213	bernd	20	0	7032	604	324	S	0.0	0.1	0:00.01	/bin/sh /etc/X11/xdg/xfce4/xinitrc -- /etc/X11/xinit/xserverrc
227	bernd	20	0	45832	6340	4516	S	0.5	1.2	0:00.38	xfce4-session
240	bernd	20	0	60800	13072	10436	S	0.0	2.6	0:04.45	xfdesktop --display :0.0 --sm-client-id 22cd2ee02-095c-497d-95c5-3f
341	bernd	20	0	60800	13072	10436	S	0.0	2.6	0:01.88	xfdesktop --display :0.0 --sm-client-id 22cd2ee02-095c-497d-95c5
319	bernd	20	0	60800	13072	10436	S	0.0	2.6	0:00.00	xfdesktop --display :0.0 --sm-client-id 22cd2ee02-095c-497d-95c5
237	bernd	20	0	52500	17740	13700	S	0.0	3.5	0:03.95	xfce4-panel --display :0.0 --sm-client-id 2395bc512-8ea1-484d-8f6d-
2499	bernd	20	0	41028	17832	15716	S	0.9	3.5	0:00.11	xfce4-screenshooter
2500	bernd	20	0	41028	17832	15716	S	0.0	3.5	0:00.00	xfce4-screenshooter
386	bernd	20	0	59832	16844	12772	S	0.0	3.3	0:19.08	xfce4-terminal
1088	bernd	20	0	7328	2632	2192	S	0.0	0.5	0:00.08	bash
2494	bernd	20	0	7304	3516	2524	R	0.5	0.7	0:00.25	htop
867	bernd	20	0	7328	2776	2328	S	0.0	0.5	0:00.23	bash
2406	bernd	20	0	7220	3316	2956	S	0.0	0.6	0:00.00	bash
2495	bernd	20	0	7656	3784	3208	S	0.0	0.7	0:00.00	zsh
390	bernd	20	0	2320	424	324	S	0.0	0.1	0:00.00	gnome-pty-helper
388	bernd	20	0	59832	16844	12772	S	0.0	3.3	0:00.00	xfce4-terminal
387	bernd	20	0	59832	16844	12772	S	0.0	3.3	0:00.00	xfce4-terminal
288	bernd	20	0	26412	5684	4196	S	0.0	1.1	0:00.04	/usr/lib/xfce4/panel/wrapper /usr/lib/xfce4/panel/plugins/libact
285	bernd	20	0	25412	4776	3488	S	0.0	0.9	0:00.05	/usr/lib/xfce4/panel/wrapper /usr/lib/xfce4/panel/plugins/libsys
277	bernd	20	0	52500	17740	13700	S	0.0	3.5	0:01.14	xfce4-panel --display :0.0 --sm-client-id 2395bc512-8ea1-484d-8f
273	bernd	20	0	52500	17740	13700	S	0.0	3.5	0:00.00	xfce4-panel --display :0.0 --sm-client-id 2395bc512-8ea1-484d-8f
236	bernd	20	0	58392	8704	6060	S	0.0	1.7	0:00.17	Thunar --sm-client-id 294bb3ebf-25c4-45e3-befb-db43d03533dd --daemon
321	bernd	20	0	58392	8704	6060	S	0.0	1.7	0:00.00	Thunar --sm-client-id 294bb3ebf-25c4-45e3-befb-db43d03533dd --daemon
239	bernd	20	0	58392	8704	6060	S	0.0	1.7	0:00.00	Thunar --sm-client-id 294bb3ebf-25c4-45e3-befb-db43d03533dd --daemon
235	bernd	20	0	45832	6340	4516	S	0.0	1.2	0:00.00	xfce4-session
234	bernd	20	0	28752	13304	10936	S	0.0	2.6	0:01.82	xfwm4 --display :0.0 --sm-client-id 20afbcb06-ea46-40c1-a07e-8fe55b
228	bernd	20	0	45832	6340	4516	S	0.0	1.2	0:00.00	xfce4-session
169	root	20	0	103M	42220	8168	S	1.9	8.3	0:42.32	/usr/bin/X -nolisten tcp vt07 -auth /var/run/slim.auth
147	root	20	0	4376	412	324	S	0.0	0.1	0:00.00	/sbin/agetty --noclear tty1 linux
141	dbus	20	0	4604	1896	1364	S	0.0	0.4	0:00.55	/usr/bin/dbus-daemon --system --address=systemd: --nofork --nopidfile --system
140	root	20	0	3148	224	8	S	0.0	0.0	0:00.22	/usr/lib/systemd/systemd-logind
139	root	20	0	55044	5420	4280	S	0.0	1.1	0:03.08	/usr/bin/NetworkManager --no-daemon
2371	root	20	0	2488	1800	1664	S	0.0	0.4	0:00.00	/usr/bin/dhccpd -B -K -L -G -c /usr/lib/networkmanager/nm-dhcp-client.act
153	root	20	0	55044	5420	4280	S	0.0	1.1	0:00.00	/usr/bin/NetworkManager --no-daemon

1 Help F2 Setup F3 Search F4 Filter F5 Sorted F6 Collap F7 Nice F8 Nice + F9 Kill F10 Quit

HIGH-LEVEL VIEW: STARTING NEW APPLICATION PROCESS



PROCESS TREE ON ANDROID

```
130|shell@grouper:/ $ ps
```

USER	PID	PPID	VSIZE	RSS	WCHAN	PC	NAME
root	120	1	9748	1016	ffffffff	00000000	S /system/bin/netd
root	121	1	1032	236	ffffffff	00000000	S /system/bin/debuggerd
system	122	1	22776	7148	ffffffff	00000000	S /system/bin/surfaceflinger
root	123	1	678556	46020	ffffffff	00000000	S zygote
drm	124	1	12588	5112	ffffffff	00000000	S /system/bin/drmserver
media	125	1	24876	7824	ffffffff	00000000	S /system/bin/mediaserver
install	126	1	996	216	ffffffff	00000000	S /system/bin/installd
keystore	128	1	3388	1236	ffffffff	00000000	S /system/bin/keystore
root	130	1	988	416	ffffffff	00000000	S /system/bin/tf_daemon
media_rw	132	1	3544	188	ffffffff	00000000	S /system/bin/sdcard
gps	133	1	9760	2380	ffffffff	00000000	S /system/bin/glgps
shell	134	1	5616	184	ffffffff	00000000	S /sbin/adbd
root	189	2	0	0	ffffffff	00000000	S flush-179:0
root	401	2	0	0	ffffffff	00000000	S irq/210-host_sp
root	403	2	0	0	ffffffff	00000000	S irq/214-host_sp
root	410	2	0	0	ffffffff	00000000	S irq/218-host_sp
shell	483	134	1288	688	c010d328	40193790	S logcat
system	498	123	781020	58348	ffffffff	00000000	S system_server
u0_a31	580	123	724900	50892	ffffffff	00000000	S com.android.systemui
wifi	597	1	3444	2380	ffffffff	00000000	S /system/bin/wpa_supplicant
u0_a32	704	123	709992	38552	ffffffff	00000000	S com.google.android.inputmethod.latin
u0_a60	720	123	687532	21160	ffffffff	00000000	S com.nuance.xt9.input
radio	733	123	703012	29344	ffffffff	00000000	S com.android.phone
nfc	746	123	703812	25736	ffffffff	00000000	S com.android.nfc
u0_a33	760	123	720624	46996	ffffffff	00000000	S com.android.launcher
u0_a21	800	123	846560	41256	ffffffff	00000000	S com.google.android.gms
u0_a21	814	123	728632	39768	ffffffff	00000000	S com.google.process.gapps
u0_a14	882	123	695896	31168	ffffffff	00000000	S android.process.media
u0_a21	912	123	731184	37948	ffffffff	00000000	S com.google.process.location
u0_a13	1177	123	692432	26184	ffffffff	00000000	S com.google.android.deskclock
u0_a45	1262	123	719612	37348	ffffffff	00000000	S com.android.vending
u0_a20	1307	123	707500	31036	ffffffff	00000000	S com.google.android.gm
u0_a9	1407	123	695448	25968	ffffffff	00000000	S com.android.chrome
u0_a53	1426	123	717764	34820	ffffffff	00000000	S com.google.android.talk
u0_a38	1553	123	705228	32540	ffffffff	00000000	S com.google.android.music:main
u0_a7	1591	123	688408	24784	ffffffff	00000000	S com.android.providers.calendar
dhcp	1666	1	1024	468	ffffffff	00000000	S /system/bin/dhccpd
root	1704	2	0	0	ffffffff	00000000	S irq/200-host_sp
u0_a48	1757	123	689760	22900	ffffffff	00000000	S com.google.android.setupwizard
u0_a47	1776	123	715156	52048	ffffffff	00000000	S com.google.android.apps.plus
u0_a35	1798	123	730144	34396	ffffffff	00000000	S com.google.android.apps.magazines