

## Hands-On Exercises for

# Android Debugging and Performance Analysis

**v. 2015.04**

### **WARNING:**

The order of the exercises does not always follow the same order of the explanations in the slides. When carrying out the exercises, carefully follow the exercise requirements. Do **NOT** blindly type the commands or code as found in the slides. Read every exercise **in its entirety** before carrying out the instructions.



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These exercises created by: Karim Yaghmour

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### Working with the AOSP sources

1. Generate and run the idegen script
2. Add the Android's sources as a Java project
3. Explore Android Studio's Java sources browsing capabilities (i.e. try out the shortcuts suggested a developer.android.com)

### Kernel tools and capabilities

1. Look for the system\_server's memory usage in the /proc filesystem
2. Reconfigure the kernel to support:
  - a. The "function" and "function\_graph" tracers. Make sure you enable CONFIG\_DYNAMIC\_FTRACE and disable CONFIG\_STRICT\_MEMORY\_RWX.
  - b. Modules and module unloading. You don't need to enable forced module unloading.

Here's a reminder on how to get the kernel configuration that uses the default "flo" configuration as its starting point:

```
$ cd kernel/msm/  
$ make ARCH=arm flo_defconfig  
$ make ARCH=arm menuconfig
```

3. Rebuild, reflash, reboot. To rebuild the kernel, you need to do the following from the "kernel/msm/" directory -- note the "..." which you'll have to replace with the path to your AOSP:

```
$ export TARGET=/home/.../kernel/gcc/arm-eabi-4.6/bin/arm-eabi  
$ make ARCH=arm CROSS_COMPILE=${TARGET}-
```

In order for the AOSP to take your newly built kernel into account, you'll need to do this -- the following assuming that you've run the appropriate ". build/envsetup.sh" and "lunch" from the toplevel:

```
$ croot  
$ cd device/asus/flo-kernel/  
$ cp kernel kernel-orig  
$ croot  
$ cp kernel/msm/arch/arm/boot/zImage device/asus/flo-kernel/kernel  
$ make -j8
```

4. Start ftrace using the "function" tracer and monitor its output. Careful: once you start ftrace by echoing "1" into tracing\_on, it'll stay on until you stop it (i.e. echo "0" into same file).
5. Use perf-stat to measure standard counters for:
  - 60 seconds of the SurfaceFlinger execution while idle
  - 60 seconds of the system\_server process while idle
6. Use perf-record/report/annotate to profile the same
7. Use ftrace's function profiling capability to profile the same
8. Compare the results of the previous 3 exercises
9. Try using the systrace/atrace combo to monitor Android
10. Use ftrace to capture from the command line the effects of the call to the collapse and expand of the status bar -- you may need to expand the ftrace buffer size:

```
# service call statusbar 1
# service call statusbar 2
```

11. Use perf to monitor the statistics of the system\_server process while you start the browser. Make sure you're monitoring just the system\_server process.

12. Use perf to count just the number of task switches that occur when you start the calculator app.

13. Use perf to record the execution of system\_server while you open the gallery app

14. Add the circular buffer device driver located at <http://www.opersys.com/downloads/circular-driver-111207.tar.bz2> to your board's BSP (i.e. device/asus/flo/) and build it into a .ko file. The AOSP used for the class had a stub .ko file in device/asus/flo/circular-driver/ directory, it's safe to replace it with the real driver. To build the driver, you'll first need to modify the Makefile included in the driver's directory to point to the kernel found in the kernel/msm/ directory. To compile the driver, you will need to go to its directory and type a command such as -- note the "... " which you'll have to replace with the path to your AOSP:

```
$ make ARCH=arm CROSS_COMPILE=/home/.../kernel/gcc/arm-eabi-4.6/bin/arm-eabi-
```

15. Driver testing:

- Use "adb push" to get the module copied on the device
- Use "insmod" to load the driver on the target
- The driver will appear as "/dev/circchar"
- Use "echo string > /dev/circchar" to write to the circular buffer
- Use "cat /dev/circchar" to read the content of the buffer

16. Now that you've tested the driver independently, rebuild your AOSP with the new driver, reflash and reboot. The Opersys system service should be able to now use the driver directly. You can check the logcat to verify that it does.

17. Modify the driver to add a static tracepoint to monitor each read() and write() operation to it. Use trace\_printk() to achieve that, remember that you'll have to use MODULE\_LICENSE("GPL") in order to have access to this symbol. Rebuild your driver and reload it on the device. Start ftrace tracing and make sure you can see the output in the ftrace output at runtime when you do a "cat" or "echo" as above.

18. Create a kprobe that catches all calls to the ioctl() system call and logs them into ftrace using trace\_printk(). Build the kprobe as a driver, load it on your device and verify that you can see the output in ftrace's traces.

### **Native debugging/profiling tools**

1. Use strace to monitor the system calls made by the SurfaceFlinger during the startup of an app

2. Use strace to monitor the system\_server

3. Use gdb on your host to step through a call to "service list". You'll need to start the command with "gdbserver" and attach to it from the host.

4. Instrument the native parts of the Opersys system service to log to ftrace's "trace\_marker" file. Namely use the ATRACE\_\* macros to instrument:

- `opersyshw_flo.c`
- `com_android_server_OpersysService.cpp`

5. Update your target and rerun it with `ftrace` enabled and check that the instrumentation added in the previous exercise is reflected in the traces generated. Make sure you review the slides on how to enable tracing for the AOSP parts.

6. Use `gdb` on the host to step from the JNI side of the system service all the way down the driver call. IOW, add a breakpoint to `init_native()`, `read_native()` and `write_native()` and follow the calls all the way to the corresponding `open()`, `read()` and `write()` occurring in the `opersyshw HAL`.

### **Java tools**

1. With the device connected to your host, start `ddms` and check out the threads run by the `system_server` and its heap information

2. Use `traceview` and `dmtracedump` to monitor the execution the system service added in the previous section

3. Compare those results with the information collected by the `ftrace` instrumentation

4. Configure Eclipse to connect to `ddms` for your AOSP project imported earlier

5. With the `system_server` process selected in `ddms`, set a breakpoint in `frameworks/base/services/core/java/com/android/server/StatusBarManagerService.java:expandNotificationsPanel()`. Use “service call statusbar 1” to expand the status bar. Eclipse should now break into the debug view at the breakpoint you selected. Now, you can step in the Status Bar Manager's code for expanding the notifications panel.

6. With the launcher process selected in `ddms`, set a breakpoint in `packages/apps/Launcher2/src/com/android/launcher2/Launcher.java:showAllApps()`. Click on the show all apps button on Android's home screen. Eclipse should now break into the debug view at the breakpoint you selected. You can now step through the Launcher's code for showing all apps.

7. Instrument the Java side of the system service, namely `OpersysService.java`, to log to `ftrace`'s `trace_marker` file.

8. Update your system and check that you can use `ftrace` to follow all the tracepoints from the java layer, to the native layer, and into the driver.

9. Full system service debugging:

- With the `system_server` process selected in `ddms`, set breakpoints in the `Opersys` system service added earlier, namely in `read()` and `write()`
- Use `gdb` to set breakpoints in the system service's JNI code: `init_native()`, `read_native()` and `write_native()`
- Have the system service invoked using “service call opersys ...”
- Step through the code starting from the system service's java code all the way down to the HAL module's writing to the device driver.

**Extra**

1. Add a glibc-based filesystem to your AOSP by following the exercises for the Embedded Android class (see courseware at <http://www.opersys.com/training/embedded-android>)
2. Use EGL trace and/or apitrace to monitor the calls made by a couple of 3D benchmarks and their effects
3. Modify ftrace's functionality to record CPU counters on function entry/exit and report the results in the traces. Have a look at `register_ftrace_function/unregister_ftrace_function`.
4. Try getting the following to work with your AOSP:
  - ktap
  - Linaro's uprobes patch
  - The BPF triggering patches

Some of the benchmarking tools available for Android, for reference:

Apps:

- 0xbench
- AnTuTu
- Passmark
- Vellamo
- Geekbench2
- GLBenchmark
- Quadrant Standard Edition
- Linpack
- Neocore
- 3DMark
- Epic Citadel
- Androbench
- CF-bench
- SD Tools
- RL Benchmark: SQL
- Benchmark & Tuning
- A1 SD Bench
- Quick Benchmark Lite
- 3DRating benchmark
- Smartbench 2011
- NenaMark
- An3DBenchXL
- CaffeineMark
- NBench

- AndEBench
- SmartBench 2012
- RealPi
- Rowboperf

Browser-based:

- Rightware Browsermark
- Octane
- V8 browser perf
- SunSpider
- Methanol

Native/CLI:

- SPEC2000, SPEC2006
- netperf
- LMbench
- microbench
- cpueater