Android User Experience/Performance Overview and Memory Analysis

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liang.guo@archermind.com

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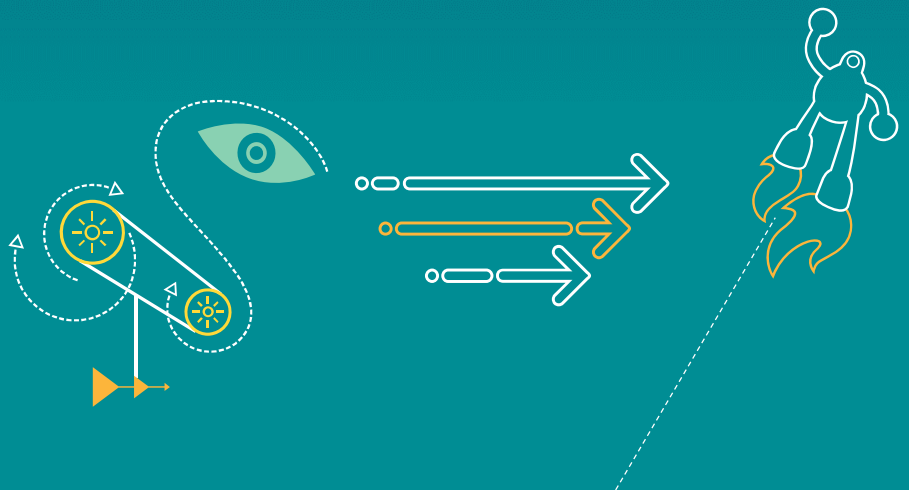

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Qualcomm Technologies, Inc.
5775 Morehouse Drive
San Diego, CA 92121
U.S.A.

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Revision History

Revision	Date	Description
A	Feb 2014	Initial release
B	Apr 2015	Updated template and legal statements and legends

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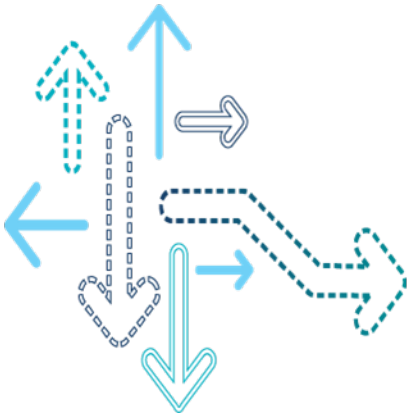
User Experience



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Key Applications of Scroll FPS and Launch Latency Measurement

FPS	Subsequent Launch Latencies (ms)
Gallery Scroll	Gallery
Home Screen Pan	Camera
Apps List	Contacts
Browser Vertical	Music
Email Scroll	Open App List
Gmail	Browser
SMS Scroll	Email
	SMS

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UX-Measurement Procedure

- For additional information, refer to *Launch Latency and FPS User Experience Measurement* (80-N8017-1).

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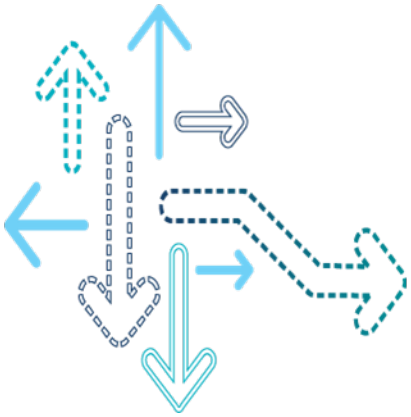
Benchmarks



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Benchmarks

- Qualcomm Technologies Inc. (QTI) uses Android benchmark applications from the Android market as indicators of product performance.
- QTI usually makes extensive study of the benchmarks before incorporating them into performance testing schedules. Detailed analysis is necessary to consider a particular benchmark and corresponding optimizations need to be implemented to deliver better results.
- Benchmarks can be categorized into System and Graphics benchmarks aimed at performance assessment of corresponding technical aspects:
  - System benchmarks are based on Dalvik VM based implementations, which need not be optimally designed and/or implemented. This risk poses a threat of misinterpreting the system performance.
  - Graphics benchmarks are relatively stable compared to System benchmarks, however, these are closely observed at QTI as serious bugs have been found in some of the very popular benchmarks, which were fixed in the later versions by the benchmark developers.

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Key Benchmarks – System, Browser, Graphics

System

Linpack (ST)
Linpack (MT)
Quadrant Pro 2.1.1
Smartbench Productivity
Antutu
CFBench

Browser

Sunspider
V8
Octane
Vellamo 2 HTML 5

Graphics

Basemark X - Offscreen

Egypt Classic - Offscreen 1080p
GLB 2.7 T-Rex HD C24Z16 - Offscreen ETC1 - 1080p

GLB 2.7 Egypt HD C24Z16 - Offscreen ETC1 - 1080p

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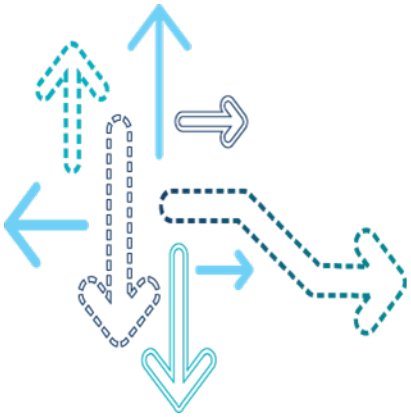
System Analysis



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System Analysis – Boot Time Analysis

- For additional information, refer to *Application Note: Android Boot Time Measurement* (80-N9266-1).
- For MSM8916/MSM8936 – TBD

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System Analysis

- Memory map, memory layout and calculations onward slides are for explanation, is not reflecting actual measurement numbers.

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System Analysis – Memory Map Information

MTP
Memory Map

Non-HLOS	**86** MB	Modem (WCDMA+GSM) ADSP WCDMA connect. etc.
HLOS Static	**15.56** MB	Kernel
HLOS Android	**410.44** MB	Apps+Firmware **227.96** MB
		Free+Cached **182.48** MB

WVGA 512 MB

OEM
Memory Map

Non-HLOS	**86** MB	Modem and others
HLOS Static	**1** MB	FB PMEM
	20 MB	Kernel
HLOS Android	**405** MB	Apps+Firmware **249** MB
		Free+Cached **166** MB

HVGA 512 MB

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System Analysis – Procedure to Derive Memory Map

- Set up the Device
  - Power-on the device
  - No SIM and no SD card
  - Enable Wi-Fi and connect to a wireless network
  - Complete Google-Sign on
    - Open Gmail app and sign-in
  - Launch Contacts App and let it sync contacts
    - Please wait for 5 minutes to make sure all contacts get download on the device and sync is complete.
  - Reboot the device and after the device rebooted; please leave it idle until the display turns off.
  - Collect kernel log, i.e., dmesg log with the below command
    “adb shell dmesg > dmesg.txt”
  - Collect meminfo with the command
    - “adb shell cat /proc/meminfo > Meminfo.txt”
  - Generate Memmap following the instructions below.
  - Ensure to take the logs for 3 to 4 iterations to remove the variance

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System Analysis – Procedure to Derive Memory Map (cont.)

- Instructions to generate Memory Map
  - Memory map is divided into three major areas:
    - Non-HLOS memory
    - HLOS-Static memory (includes ION Carveout memory and Frame Buffer memory
    - Kernel and Userspace memory
- A sampled message output is given below:
  - <6>[0.000000] tmc@fc326000 reserved EBI1 size 100000
  - <6>[0.000000] qcom,mdss_fb_primary reserved EBI1 size 800000
  - <6>[0.000000] Node qcom,msm-mem-hole removed memory 7b00000-df00000
  - <6>[0.000000] qcom,msm-rtb reserved EBI1 size 100000
  - <6>[0.000000] memory pool 3 (start 0x1f600000 size a00000) initialized
  - <6>[0.000000] Memory – 123 MB 279 MB
    = 402 MB total

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System Analysis – Procedure to Derive Memory Map (cont.)

- Memory Pool size (0xa00000) represents HLOS-Static memory.
- In this example, it includes the following:
  - Debug heap TMC = 1 MB
  - Frame Buffer = 8 MB
  - Debug heap RTB = 1 MB
- The Kernel and Userspace memory is 402 MB from the above dmesg.
- Non-HLOS memory = Total RAM – (Kernel andUserspace +HLOS Static) = 512 MB – (402+10) = 100 MB
- Kernel and Userspace memory is divided into the following:
  - Kernel size
  - Userspace Memory
    - Apps+Firmware
    - Free Memory

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System Analysis – Procedure to Derive Memory Map (cont.)

- From /proc/meminfo, the following are calculated:
  - Userspace Memory = MemTotal (from the /proc/meminfo = 385 MB)
  - Free Memory = Memfree+Cached (from /proc/meminfo = 134 MB)
  - So, the Kernel size = (Kernel and Userspace) – Userspace = 402 MB – 385 MB = 17 MB
  - And, the Apps+Firmware = Userspace Memory – Free Memory = 385 MB – 134 MB = 251 MB

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System Analysis – Memory

Areas of Savings	Memory Additionally Used by OEM	Comments
Frame Buffer Size	1 MB	OEM's use Frame buffer for some specific features like Offline charging. In some cases, we have adjusted the memory according to the display resolution.
Non HLOS	0 MB	Some unnecessary logs can be removed and boundaries alignment can be fine tuned to see some memory savings on Non-HLOS portion
KERNEL	5	OEM used extra drivers and extra debug info of their own which caused increase in kernel area
APPS+Firmware	21	OEM has its own specific applications which consume a lot of memory
Total Memory Additionally used	**27 MB**	

Note: The memory map presented in the earlier slide reflects the system memory state. The HLOS component present is explained in detail in later slides.

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System Analysis – Memory (cont.)

- Memory analysis can be done broadly basing on HLOS and non-HLOS memory footprints.
- The HLOS memory map covers the memory footprint processes and or services that are always running in the system.
- The non-HLOS footprint comprises of components like TrustZone, WCNSS, ADSP, LPASS and Modem.
- There is usually very little scope left in the non-HLOS for memory optimization as most of it is usually fixed on a modem and features that OEM decides to release the product.
- However, there is a fair amount of scope for improving memory situation on HLOS memory footprint.
- The Kernel, Applications and Framework present a decent scope of looking at gaining free memory.

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System Analysis – HLOS Memory Map

- The following memory map though fairly comprehensive in covering HLOS footprint doesn't cover all aspects of HLOS memory usage. The same is revealed when compared with APPS+Firmware component in the system Memory Map.
- The services and or Cached processes running in the HLOS are randomly killed based on Low memory killer coming in to picture and or if BG application limit is crossed.
- There are other aspects like ION and KGSL memory allocations to be considered when evaluating HLOS memory footprint.

Process type	MTP (MB)	OEM (MB)
Home App	0	17.2
Native	48	45
Persistent	51.5	60.3
Foreground	15.3	13.1
Visible	8.5	9.9
Perceptible	5.8	7.4
A Services	12.3	15.3
B Services	11.4	16.2
Cached	73.9	60.4
Total	**226.3**	**244.8**

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System Analysis – HLOS Memory Map

- The KGSL allocations happen whenever the application requests memory to be allocated for rendering of different layers.
- ION memory allocations happen for different components like audio, ADSP, PIL etc., dynamically.
- The above allocations have to be considered as well for memory analysis in HLOS.
- On a closer comparison with System memory Map and HLOS memory map, it can be easily understood that free memory available is not always at the value depicted in the System Memory map.
- The Free memory keeps on changing depending upon system state and the kind of applications in use.
- As such the whole scenario of looking for free memory in the system takes a different approach and this has come to be estimated and evaluated in a new term named as HEAD ROOM.

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System Analysis – Head Room

- Head Room Concept
  - Linux will never refuse for memory, it will kill you if you ask more.
  - The system memory performance can be properly be evaluated by the maximum amount of RAM an app can be allocated(HEAD ROOM)
  - To be able to determine the headroom, an app has to be developed which will help determine the max. free memory that can be given to an app.
  - The app should continuously allocate 1 MB of memory every 200ms until it gets killed.
  - The app should also track the time taken for each of its allocations.
  - During the app run, LMK starts killing the apps based on the memory threshold triggers.

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System Analysis – Head Room

- Framework – Minimal OS memory that has to be resident.
- Imp – Important Apps and services Android expects to always be present
- FG Headroom – Maximum memory available to a foreground app
- BG Headroom – Maximum memory available to a background app

OEM
Memory Map

Non-HLOS	**86** MB	Modem and others
HLOS Static	**1** MB	FB PMEM
	20 MB	Kernel
HLOS Android	**405** MB	Apps+firmware **249** MB
		Free+Cached **166** MB

HVGA 512 MB

OEM
Head Room Memory Map

Non-HLOS	**86** MB	Modem and others	
HLOS Static	**1** MB	FB PMEM	
	20 MB	Kernel	
HLOS Android	**405** MB	Firmware **150** MB	Firmware+ Imp Apps **200** MB
		FG H'room **255** MB	BG H'room **205** MB

HVGA 512 MB

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System Analysis – Kernel

- Kernel Configuration
  - It is recommended to use <chipset>-perf_defconfig as the user build reference configuration. This is tuned for better system performance and will show up as better kernel memory foot print.
    - Ex – msm8226-perf_defconfig
    - Ex – msm8974-perf_defconfig
  - For example, most OEM's as default enable RTB driver in kernel which takes around 1 MB of memory. The same module may be removed on production binaries to save memory.
- Ion Allocations
  - To find out the ION allocations the below steps may be followed.

```
mount –t debugfs none /sys/kernel/debug
adb pull /sys/kernel/debug/ion ion
grep "total  " ion/heaps/system
```

  - The output of the grep "total " command is sum of all the ION allocations in the system.

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System Analysis – Kernel (cont.)

- KGSL Allocations
  - To find out the total KGSL allocations in the system, the below steps may be used

```
mount –t debugfs none /sys/kernel/debug
adb pull /sys/class/kgsl/kgsl/ kgsl
cat kgsl/page_alloc
```

  - The output of the cat is the total kgsl allocation in the system. During Memory leak situation, KGSL and ION allocations have to checked in detail.
- KSM Memory Savings
  - KSM feature saves memory in the HLOS space. To find out the memory savings because of KSM, the below steps may be used.

```
mount –t debugfs none /sys/kernel/debug
adb pull /sys/kernel/mm/ksm/ ksm
adb shell dumpsys meminfo > dumpsys-meminfo.txt
grep KSM dumpsys-meminfo.txt | tr -s ' ' | awk '{ print "KSM-Savings " ($2-$7)/1024 }‘
```

  - The KSM-Savings will give the total savings from KSM.

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System Analysis – Kernel (cont.)

- ZRAM Memory Savings
  - To find out the savings gained from using ZRAM:
    - adb pull /sys/block/zram0/ zram
    - Adb shell dumpsys meminfo > dumpsys-meminfo.txt
    - grep ZRAM dumpsys-meminfo.txt | tr -s ' ' | awk '{ print "ZRAM-Savings " ($7 - $2)/1024 }'
  - The ZRAM-Savings will give the total ZRAM savings.
- Frame Buffer Size Calculation
  - Frame will directly affect the free memory and mainly affect the system User experience.
  - The Frame in latest android is not carved out in terms of PMEM and is dynamically allocated.
  - The value is set under corresponding dtsi files.
  - The formula to calculate frame buffer size when using Triple Buffering is
  - Display resolution * 4 bytes (32bpp) * 3 (3 in case of Triple buffering)
  - OEM's in some cases use double buffering.

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System Analysis – Kernel (cont.)

- Kernel's Virtual Memory Layout (from "dmesg logs“)
  - <5>[0.000000] Virtual kernel memory layout:
  - <5>[0.000000] vector – 0xffff0000 - 0xffff1000 (4 kB)
  - <5>[0.000000] fixmap – 0xfff00000 - 0xfffe0000 (896 kB)
  - <5>[0.000000] vmalloc – 0xdd000000 - 0xff000000 (544 MB)
  - <5>[0.000000] lowmem – 0xc0000000 - 0xdcf00000 (463 MB)
  - <5>[0.000000] pkmap – 0xbfe00000 - 0xc0000000 (2 MB)
  - <5>[0.000000] modules – 0xbf000000 - 0xbfe00000 (14 MB)
  - <5>[0.000000] .text – 0xc0008000 - 0xc084fbe8 (8479 kB)
  - <5>[0.000000] .init – 0xc0850000 - 0xc0887a00 (223 kB)
  - <5>[0.000000] .data – 0xc0888000 - 0xc094a488 (778 kB)
  - <5>[0.000000] .bss – 0xc094a4ac - 0xc0b2d614 (1933 kB)

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System Analysis – Kernel (cont.)

- The log helps us understand the kernel Virtual memory layout.
  - Init – The range where the kernel's initial page tables reside. This minimal address space is just large enough to install the kernel in the RAM and to initialize its core data structures.
  - Text – The range where the kernel code resides.
  - Data – The range where the kernel data segments reside.
  - Lowmem – The lowmem range can be used by the kernel to directly access physical addresses.
  - Vmalloc – Virtual memory allocation can allocate page frames based on a noncontiguous scheme. The main advantage of this schema is to avoid external fragmentation during application memory allocation.
  - Pkmap – The permanent kernel mapping allows the kernel mappings of high-memory page frames into the kernel address space.
  - Fixmap – These are fix-mapped linear addresses which can refer to any physical address in the RAM.

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System Analysis – Kernel (cont.)

- Kernel's text, data, and BSS segments in brief:
  - size vmlinux
  - The following table shows overall kernel sizes in terms of buffers

text	data	bss	dec	hex	filename
8863295	837372	1978708	11679375	b2368f	vmlinux

- size */built.-in.o
  - The following table shows the subsystem wise buffer allocation kernel:

text	data	bss	dec	hex	filename
107677	3950	1204	112831	1b8bf	block/built-in.o
119928	3578	12	123518	1e27e	crypto/built-in.o
2752302	301242	1130524	4184068	3fd804	drivers/built-in.o
1268989	28372	3676	1301037	13da2d	fs/built-in.o
13094	3484	136	16714	414a	init/built-in.o
24986	708	8	25702	6466	ipc/built-in.o
707760	163525	369152	1240437	12ed75	kernel/built-in.o
78293	25932	2300	106525	1a01d	lib/built-in.o
353991	19904	25920	399815	619c7	mm/built-in.o
1514480	88474	21200	1624154	18c85a	net/built-in.o
7163	556	8	7727	1e2f	security/built-in.o
193923	8180	1452	203555	31b23	sound/built-in.o

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System Analysis – Kernel (cont.)

- TOP RAM consuming symbols
  - nm -t d -l -r --size-sort -S vmlinux | head -50
    - The above command helps us understand the buffer allocations in the kernel.
    - OEM's sometimes allocate huge buffers for logcat thereby showing less free memory.
    - Such situation can be easily found by using the above command.

Start-Addr	Size	Size (in KB)	Type	Symbol-Name	Source-Location
3230979372	320000	312.50	b	debug_buffer	kernel/arch/arm/mach-msm/smem_log.c:1879
3232660688	262144	256.00	b	_buf_log_system	kernel/drivers/staging/android/logger.c:734
3232398544	262144	256.00	b	_buf_log_radio	kernel/drivers/staging/android/logger.c:733
3231874256	262144	256.00	b	_buf_log_main	kernel/drivers/staging/android/logger.c:731
3232136400	262144	256.00	b	_buf_log_events	kernel/drivers/staging/android/logger.c:732
3231610648	131076	128.00	b	map_pid_to_cmdline	kernel/kernel/trace/trace.c:970
3231391625	131072	128.00	b	__log_buf	kernel/kernel/printk.c:151
3230179776	123840	120.94	D	irq_desc	kernel/kernel/irq/irqdesc.c:243

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System Analysis – System Properties

- Composition
- Rendering
- Tile rendering/Dirty region rendering
- Number of layers in an APP
- Display resolution
- Wallpaper color depth
- Live wall paper FPS
- LMK settings
- Cpu freq scaling governor settings
- Cgroups settings
- Sqlite settings
- Swaprect
- Gpu clock speed
- DDR Speed
- Dumpsys meminfo

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System Analysis – System Properties (cont.)

- Dumpsys SurfaceFlinger
- LCD pixel density/Screen length
- Mpdecision
- Thermal daemon
- BG APPS Limit

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System Analysis – System Properties (cont.)

- Composition
  - The composition property decides the hardware to be used for composing the frames. OEM's usually change the property randomly which in some cases can cause undesired User experience in terms of launch latencies and Scroll performance.
  - As a default "dyn" composition is recommended.
- Rendering
  - The process of drawing images is known as rendering.
  - Software rendered apps usually perform poor in terms of scroll FPS, compared to hardware rendered applications, however the memory consumed by software rendered applications in some cases is smaller compared to Hardware rendered applications.
  - As a default Hardware rendering is always recommended as it is most supported and recommended for better User experience
- Tiled Rendering/Dirty Region rendering
  - The frame enabled rendering in form tiles for better performance. However, dirty region rendering further improves performance by redrawing only the changed tiles.

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System Analysis – System Properties (cont.)

- Number of layers in an APP
  - The number layers in an application also determine its User experience.
  - If the number of layers are more, then there's scope of launch latencies and memory used by the app being higher.
  - The layer composition usually varies depending upon the number of layers as well.
  - If the layers are 3 or more there's a good chance of the app having poor performance, if the MDP is not able to compose the layers.
- Display resolution
  - The display resolution affects the overall system User Experience, benchmarks and memory as well.
  - The Frame buffer memory is based on display resolution
  - The 2D graphics score in benchmarks and UX are usually different whenever comparison is done between two devices using same chipset and different display resolutions.
- Wallpaper color depth
  - The wall paper color depth is usually set at 32bpp.
  - This consumes around <display –resol> * 4 bytes. In scarce memory situations and when display resolution is HVGA and below, OEM's may choose to reduce the color depth to 16bpp without affecting any visual experience.

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System Analysis – System Properties (cont.)

- Live wall paper FPS
  - Google recommends that the Live wall paper FPS shouldn't exceed 20.
  - This can estimated using calc_fps procedure described later and usually is tested using the Google Nexus Live wall paper.
  - If the FPS of Live wall paper is any higher, the Home Screen pan performance may be bad.
- LMK settings
  - Latest releases of Android have modified LMK driver to auto detect and set the LMK driver parameters based on display resolution and device memory.
  - If the LMK driver settings are tweaked, Launch latencies of apps get affected.
- Cgroups settings
  - Cgroups have to configured in the system properly for better User experience.
  - Cgroups sanity may be checked using cpueater tool.
  - All the bg apps in cgroups, should not take more than 10% of the CPU when an FG app is running. Likewise, FG app can consume up to 90% of the CPU in the same situation.
- Sqlite settings
  - Sqlite settings are never to be tweaked as it can result unstable behavior of contacts app.

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System Analysis – System Properties (cont.)

- Swaprect
  - Swaprect, similar to dirty region rendering will compose only dirty regions.
  - Swaprect will affect scroll FPS and can be checked from resolve logs.
- Gpu clock speed
  - To debug gaming performance issues, pwr_scale policy for GPU is turned OFF to see if the GPU frequency scaling is an issue
- DDR Speed
  - The DDR speed will affect the system and graphics benchmarks.
  - The bw_mem tool described later will help in evaluating DDR performance.
  - DDR frequencies are usually voted for by applications performance.
  - For ex – some multimedia features like VOIP calls need DDR speed to be optimal even during suspend mode for glitch free performance.
  - The clock plans have to adjusted accordingly in the above case.
- Dumpsys meminfo
  - The “adb shell dumpsys meminfo” helps us understand the HLOS memory usage.
  - The command will also help in getting in depth usage info for a particular process as well.

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System Analysis – System Properties (cont.)

- Dumpsys SurfaceFlinger
  - The “adb shell dumpsys SurfaceFlinger” command helps in understanding following about an app.
  - The no. of layers in app
  - The z-order or the order of layers composed,
  - The amount of memory used by each layer,
  - The composition hardware used by each layer,
  - Color depth or bpp of each layer
- LCD pixel density/Screen length
  - The pixel density and screen are interdependent entities and directly affect the screen supported.
  - http://developer.android.com/guide/practices/screens_support.html
  - The Android CDD defines specific values for density which affect the 2D graphics performance across the system

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System Analysis – System Properties (cont.)

- The pixel density values also affect the type of resource files in the applications, which not only affect the launch latencies but also affect the memory utilization by each as the application resources are preloaded in to the memory.
- The cache settings which affect gaming performance and 2D graphics performance, defined under the below link are also affected by the density
  - http://source.android.com/devices/tuning.html
- Mpdecision
  - The mpdecision affects the device CPU cores going online and offline based on the run queue stats of the scheduler.
  - This affects the overall system performance and if incorrectly tuned, can be a root cause for the device sluggishness.

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System Analysis – System Properties (cont.)

- Thermal daemon
  - The thermal daemon in the device affects the CPU frequency depending on the core temperature.
  - At higher temperatures, the device CPU frequency will be scaled down to lower values.
  - OEM's have been found to tweak this daemon, resulting in poor benchmark scores and in some cases glitches in VoIP calls during suspend mode because of thermal daemon getting kicked.
- Dalvik heap settings
  - The default google dalvik settings are always recommended to be used.
  - The settings are always known to affect the following when set incorrectly.
  - Poor application Launch latencies due to concurrent GC's.
  - Poor free memory
  - In some cases sluggish game performance as well
  - The settings are usually supposed to be taken from frameworks/native/build/<make-file> and set under system.prop file
  - The settings in the make files are based on the device RAM size, display resolution and dpi (pixel density).

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System Analysis – System Properties (cont.)

- BG APPS LIMIT
  - The bg app limit property affects the number of applications running in the system.
  - The applications may be under services or cached applications and can be found using the dumpsys meminfo command.
  - This property affects the launch latencies, HLOS memory footprint and system user experience.
  - OEM's have to consider the number and the size of their applications to fine tune the BG apps limit value.
  - To see better launch latencies by reducing SIG KILLS from LMK killer
  - Better HLOS memory foot print because of reduced number of apps running under services and cached applications.

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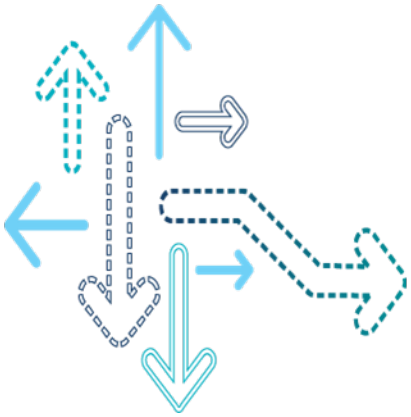
Analysis Tools



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Analysis Tools – Calc FPS

- CALC_FPS displays FPS in logcat logs as calculated from framebuffer HAL.
  - Hot to use Calcfps?
    - adb shell setprop debug.gr.calcfps 1 →Enabling clacfps feature
    - adb shell setprop debug.gr.calcfps.period 1 →Setting the interval in frames
    - adb shell stop
    - adb shell start
    - adb logcat | grep FPS →Collecting FPS logs in logcat
- The interval of 1 frame is closest reliable value to check FPS. So that it gives info of FPS per each frame.
  - Example logs
    - D/qdutils (4274): FPS for last 1 frames: 60.12
    - D/qdutils (4274): FPS for last 1 frames: 59.57
    - D/qdutils (4274): FPS for last 1 frames: 60.12
    - D/qdutils (4274): FPS for last 1 frames: 60.12
    - D/qdutils (4274): FPS for last 1 frames: 59.79
    - D/qdutils (4274): FPS for last 1 frames: 59.57
    - D/qdutils (4274): FPS for last 1 frames: 52.34
    - D/qdutils (4274): FPS for last 1 frames: 8.65
    - D/qdutils (4274): FPS for last 1 frames: 36.90
    - D/qdutils (4274): FPS for last 1 frames: 41.42
    - D/qdutils (4274): FPS for last 1 frames: 71.07
    - D/qdutils (4274): FPS for last 1 frames: 60.12
    - D/qdutils (4274): FPS for last 1 frames: 60.01
    - D/qdutils (4274): FPS for last 1 frames: 59.90
    - D/qdutils (4274): FPS for last 1 frames: 59.90
    - D/qdutils (4274): FPS for last 1 frames: 59.90
    - D/qdutils (4274): FPS for last 1 frames: 60.01
    - D/qdutils (4274): FPS for last 1 frames: 59.68
    - D/qdutils (4274): FPS for last 1 frames: 60.01
    - D/qdutils (4274): FPS for last 1 frames: 61.47
    - D/qdutils (4274): FPS for last 1 frames: 60.45

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Analysis Tools – Resolve Logs

- Applications written using heavy GLRender calls can lead to poor FPS on Adreno200 family of GPU engines as there will be extra memory read/write between GPU memory and main memory.
- An ideal application will only have one resolve per render target and zero unresolves, although some exceptions exist.
- The resolve log keeps track of all unresolves and resolve performed by the graphics driver for a particular application. As part of this information, it will record the sizes and types of frame buffers, the bin layout, and the type of each resolve.

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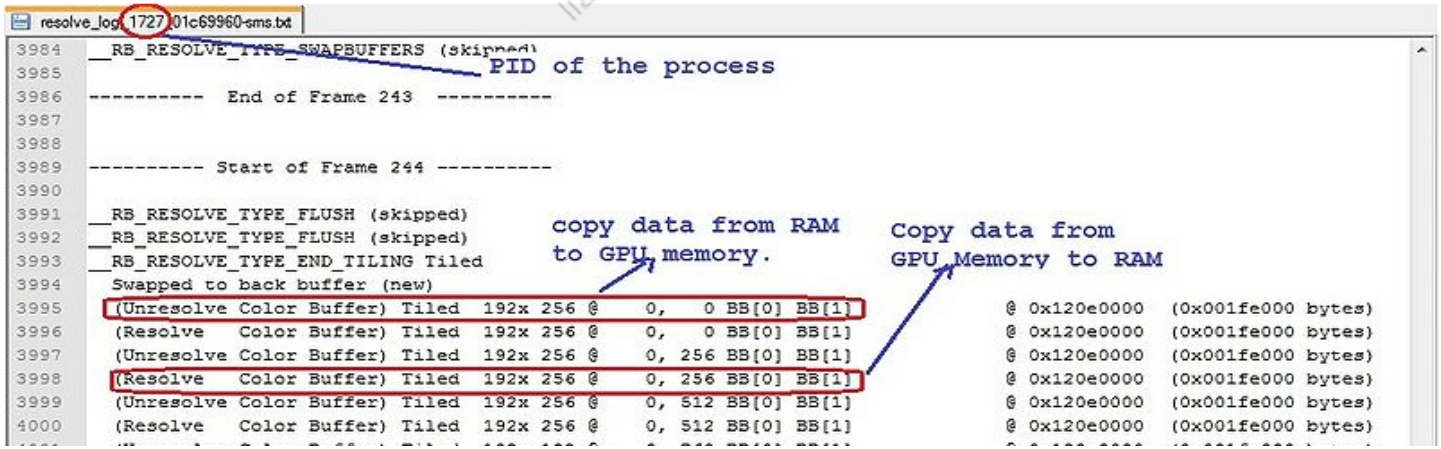
Analysis Tools – Resolve Logs (cont.)

- Enabling Resolve Logs
  - adb shell rm -r /data/local/tmp/
  - adb shell mkdir /data/local/tmp/
  - adb shell chmod 777 /data/local/tmp/
  - adb shell "echo "log.resolves=1" > /data/local/tmp/adreno_config.txt"
  - adb shell chmod 777 /data/local/tmp/adreno_config.txt
  - adb shell stop adb shell start
  - Run the scenario and then – adb pull /data/local/tmp
  - The resolve logs will be created in "/data/local/tmp" for each PID as shown below
  - resolve_log_<PID>_<RandomNumber>.txt
  - Example – resolve_log_2876_01714610.txt



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Analysis Tools

- Lmdd
  - Lmdd is great for streaming bandwidth measurement. lmdd copies a specified input file to a specified output with possible conventions and prints out the timing statistics after completing the I/O transfer.
- IOZONE
  - IOzone is a filesystem benchmark tool supporting many various operating systems. IOzone is useful for performing a broad filesystem analysis, it tests file I/O performance following operations – read, write, re-read, re-write, read backwards, read strided, fread, random read, pread, mmap, aio_read, aio_write.
- bw_mem
  - bw_mem allocates twice the specified amount of memory, zeros it, and then times the copying of the first half to the second half. Results are reported in megabytes moved per second. The size specification may end with k or m to mean kilobytes (* 1024) or megabytes (* 1024 * 1024).

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Analysis Tools (cont.)

- OProfile is a useful tool for identifying processor performance bottlenecks.
- OProfile can be configured to take samples periodically to get timer-based measurements to indicate which sections of code are taking more CPU resources to be executed on the device.
- Besides a timer-based approach, OProfile also provides access to the performance monitoring counters.
  - The performance monitoring counters allow samples to be collected on vents such as cache misses, memory accesses, instructions retired, and processor clock cycles.
  - These performance events allow developers to determine whether specific performance problems exist in the software.

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Analysis Tools (cont.)

- Qview
  - Qview is browser-based QTI tool which provides many features for users.
  - Many new features are added in each version and some prominent features are listed below.
    - Performance Counter based Oprofile interface and report generation
    - Bus profiling and NOC (Network-on-chip) monitor interface.
    - System CPU frequency monitor
    - Live View time chart interface
    - Time chart facility
    - System state capture
    - Dynamic kernel debug and Kprobe, jprobe interfaces
    - CPU register probing
- Systrace
  - Google's own tool to analyze system wide cross-functional issues and launch latencies based on Ftrace facility in the kernel.
  - http://developer.android.com/tools/help/systrace.html
  - Launch latencies and GPU performance issues are in particular very easy to debug using Systrace.

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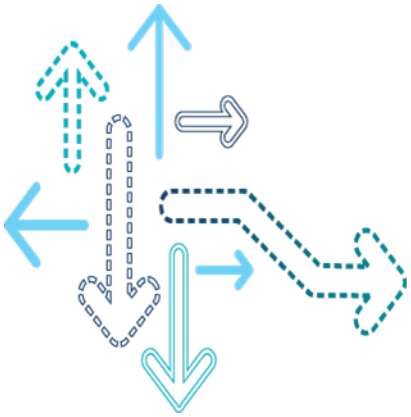
Reference Performance Patches Documents



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Performance Patches Documents

- For additional information, refer to *Application Note: Performance Improvement Patches for Android Jelly Bean Builds* (80-NC974-1), *Application Note: Performance Improvement Patches for Android Jelly Bean MR1 Builds* (80-NF450-1), and *Application Note: Performance Improvement Patches for Android KitKat Builds* (80-NL386-1).
- The above referenced documents have most of the common performance patches which affect both User Experience and Benchmarking.
- OEM's usually check their Android release to see if these patches are present.
- The above referenced documents can be downloaded from https://support.cdmatech.com.

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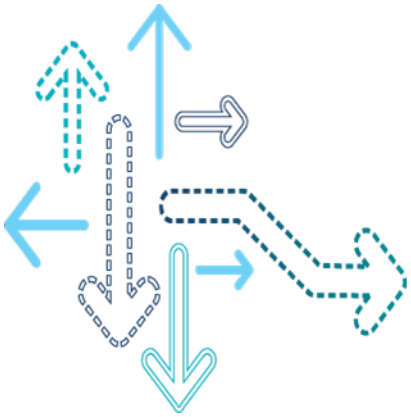
Android UX Performance Improvement Program



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Android UX Performance Improvement Program – Technical Requirements

- UX Program Baseline Build (B0) Requirements
  - All mandatory performance patches should be applied to B0 unless there is a major conflict/difference in code architecture. Get performance patch list as specified in the previous slide or Qualcomm TAM's or performance CE team.
  - Should be compiled in User mode to get closest performance to a commercial binary
  - Should allow root access in ADB shell for system checking
  - Should reduce log messages as much as possible
  - Wi-Fi should work properly for web user experience profiling
  - For sanity tests and basic performance checking, work with CE performance team members.

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Android UX Performance Improvement Program – Technical Requirements (cont.)

- If necessary, the UX program can be conducted in the nearest regional teams. Contact regional CE performance team for the proper coordination.
  - Requirements of the UX program in Build machine to build modem and apps binaries More than two build machines are preferred, if possible, to build multiple binaries simultaneously
  - Desktop is preferred, due to short compilation time
- More than eight devices with B0 build, of which at least one device has a JTAG device with JTAG adaptor
- Send five devices to Regional CE team before traveling to the site. This minimizes waiting time in region for device profiling.
  - Dedicated licensee experts for on-site support in Region – Who can integrate patches and compile source code
  - Who can track history of performance patches for later application to development trunk after UX program
  - Who can have a technical discussion or can help communication with relevant engineer from licensee.

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References

Documents	
Qualcomm Technologies, Inc.	
Application Note: Android Boot Time Measurement	80-N9266-1
Application Note: Performance Improvement Patches for Android Jelly Bean Builds	80-NC974-1
Introduction to Android User Experience Performance Improvement Program	80-N6668-2
Launch Latency and FPS User Experience Measurement	80-N8017-1
Application Note: Performance Improvement Patches for Android Jelly Bean MR1 Builds	80-NF450-1
Application Note: Performance Improvement Patches for Android Jelly Bean MR2 Builds	80-NF450-2
Application Note: Performance Improvement Patches for Android KitKat Builds	80-NL386-1

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lianhuduo@authermind.com

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liang.guo@archermind.com

Questions?

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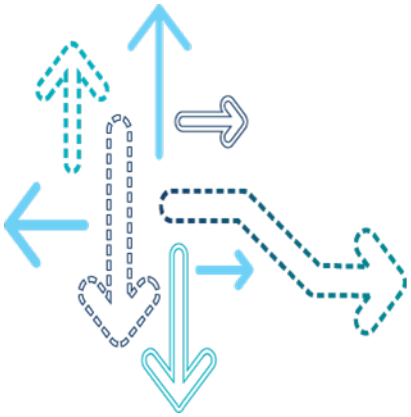

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